CONVAIR *Traveler*

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Traveler
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FOREWORD

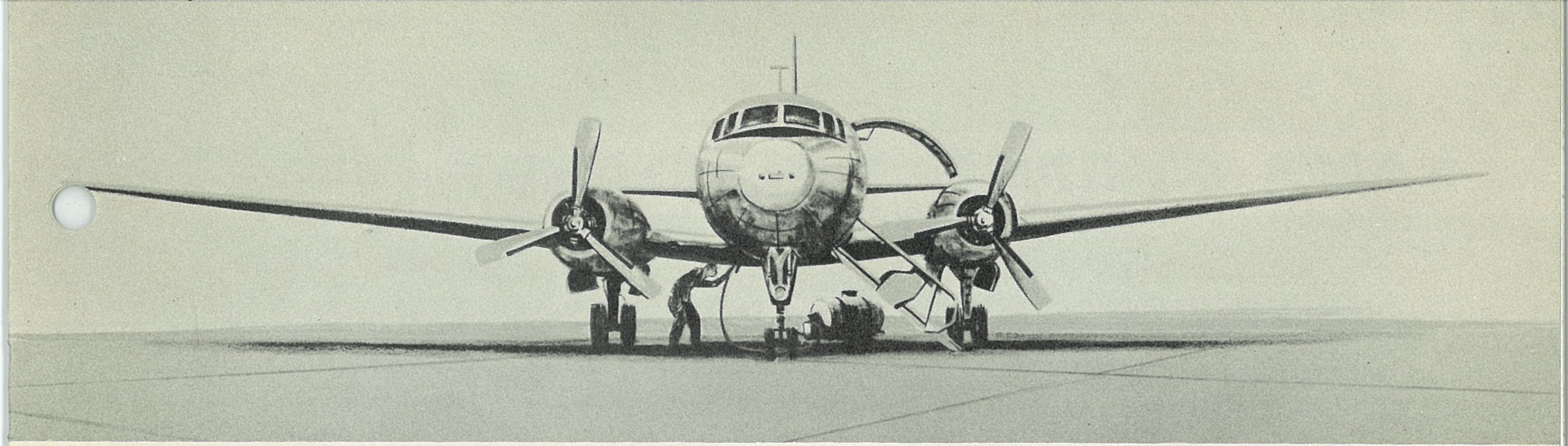
This issue of the Traveler is devoted to information on ramp turn-around servicing and comparative replenishing data on the three Convair commercial transports . . . the Convair-Liners 240 and 340, and the Metropolitan 440.

In addition to pinpointing the differences between replenishing points on these three models, information suitable for use by ground service personnel has been compiled into quick reference tables.

ON THE COVER

Servicing speed and efficiency are important design requirements at Convair. This month, artist P. Frank Freeman portrays two typical time saving operations.

A digest of Convair-Liner operation and service published monthly by the Service Publications Section of Convair in the interest of Convair-Liner operators. Communications should be addressed to Chief of Service, Convair, San Diego 12, Calif.



REPLENISHING 240 - 340 - 440

To meet the demands of competitive scheduling, today's air transports must be designed to permit efficient servicing operations. The design engineer of commercial transports is familiar with airline operation . . . he knows the needs and problems arising from equipment handling by service and ground personnel, the serviceability and accessibility of equipment, CAA requirements, and the needs and desires of passengers. All of these requirements must be incorporated in the airplane design if economical and efficient operation are to be obtained by the airline.

The Convair 240 was Convair's first venture into the commercial transport field. This new 40-passenger transport was a major advancement in commercial aviation. Its operating advantages and ease of maintenance were the result of sound engineering guided by such factors as, 1) recommendations of the Air Transport Association Group, which studied airline requirements for post-war twin-engine equipment; 2) suggestions made by representatives of leading airlines throughout the world; and 3) experience of Convair as a wartime airline operator flying 100,000,000 ton-miles of cargo and 299,600,000 passenger miles. The end product — an airplane that has been engineered to reduce to a minimum the time lost at airport stops — an airplane with "built-in" increased utilization.

The excellent servicing and maintenance characteristics of the Model 240 have been developed to an even higher level in the Models 340 and 440. Many features have been designed into these aircraft to minimize lost time at airport stops. This consideration is an important one to operations on short and medium stage lengths. The illustration on page 4 shows some of the many operations performed simultaneously and efficiently during an intermediate stop. Passengers carry their luggage aboard, the buffet is serviced, and cargo is loaded and unloaded at the belly and rear service doors.

Much other activity takes place during the typical intermediate stop. While oil and gas trucks are moving into position on the right-hand side of the airplane, passenger steps are lowered and the station agent takes his position. Passengers then deplane. Together with the gas and oil trucks, other equipment is also moving into place. The forward and belly cargo stands are moved into place, the ADI cart is positioned under the right wing between fuselage and nacelle, the air conditioning truck and lavatory service truck are located on the right-hand side of the airplane forward of the rear cargo door, and the rear cargo stand is positioned for unloading cargo. When the ground power unit is connected, the buffet service stairs are moved to the rear service door. When these stairs are in place, the fresh water service cart is positioned at the rear of the service door.

When the right wing fuel and oil tanks have been serviced, the trucks move to service the left wing tanks. Passengers may board with the trucks in this position provided the station agent is standing by the steps and smoking is prohibited on the ramp.

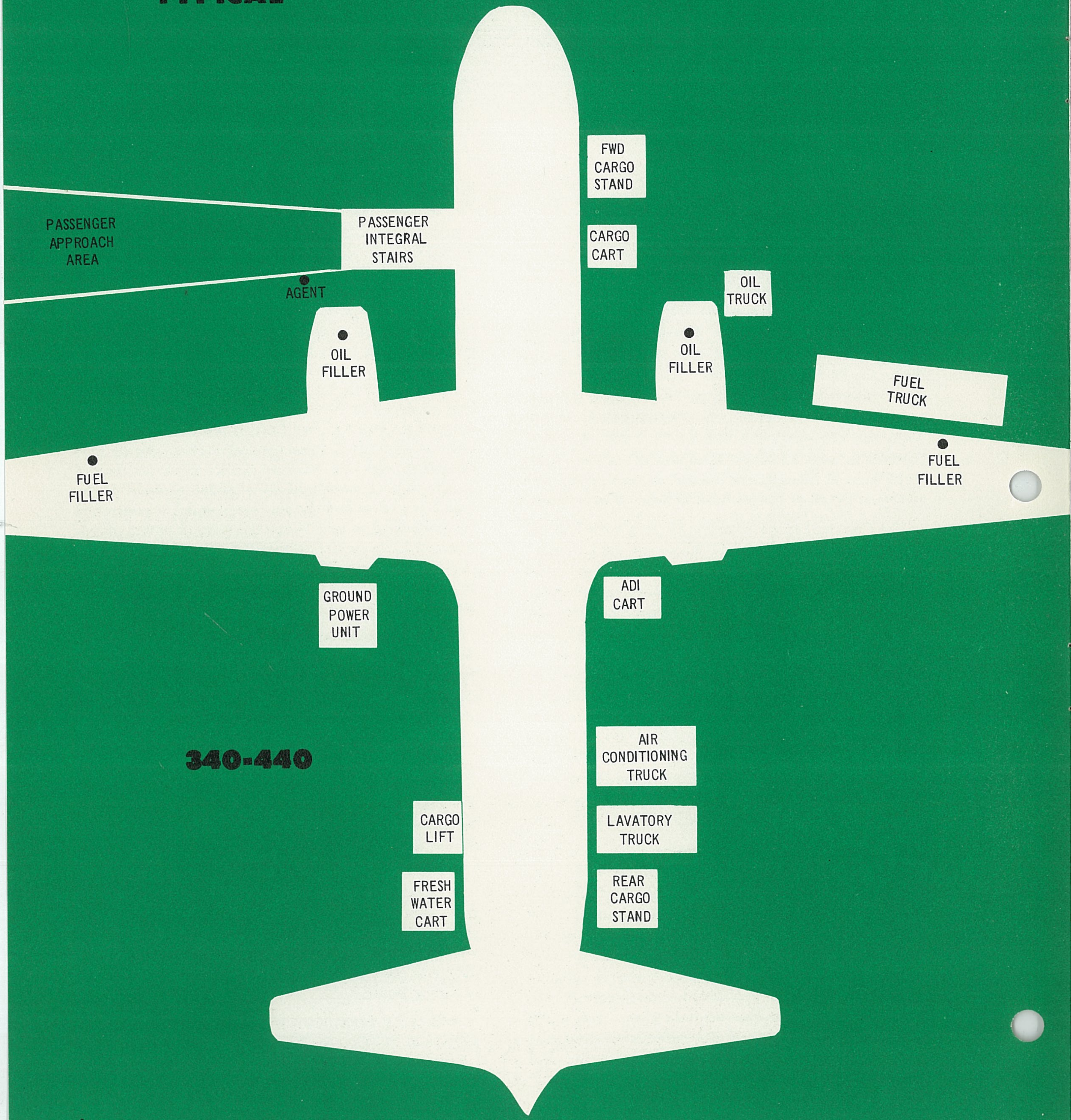
All ramp equipment except the ground power unit is moved from the airplane before the engines are started. After the stairs have been retracted and a fire guard posted, the engines are started. The ground power unit is then disconnected and moved away from the airplane. Ground servicing personnel are now free to service the next airplane.

To further increase utilization of Convair-Liner aircraft, servicing points, fluids, and instructions for replenishing have been standardized between models, wherever possible. Servicing points are easily accessible and instructions are clearly indicated adjacent to servicing points.

A detailed breakdown of the various servicing installations on Convair-Liners is presented in the following sections. Quick-reference charts are presented on pages 10 and 11.

RAMP EQUIPMENT PLACEMENT

TYPICAL



340-440

FUEL SYSTEM

Recommended fuel grades for Convair-Liner aircraft depend upon type of engine powers utilized, the CB16 engine utilizing grade 100/130, and the CB17 engine, grades 108/135 or 115/145.

Note

> If it is necessary to make use of grade 100/130 fuel, the engine must be operated as a CB16 engine and the rating for that engine must be used. Any mixture of fuel grades 100/130 with 108/135 and 115/145 necessitates operation at CB16 ratings.

Fueling of all Convair-Liners is accomplished through filler necks located on the wing upper surface. Dipsticks are incorporated in the filler caps of all models. On Models 340 and 440, the filler necks are located near the leading edges so that it is not necessary to station a man on the wing upper surface while fueling is proceeding. If the fuel truck is equipped with a rear deck, the entire operation may be conducted from the deck. On the Model 240, a man is stationed on the wing surface during the fueling operation.

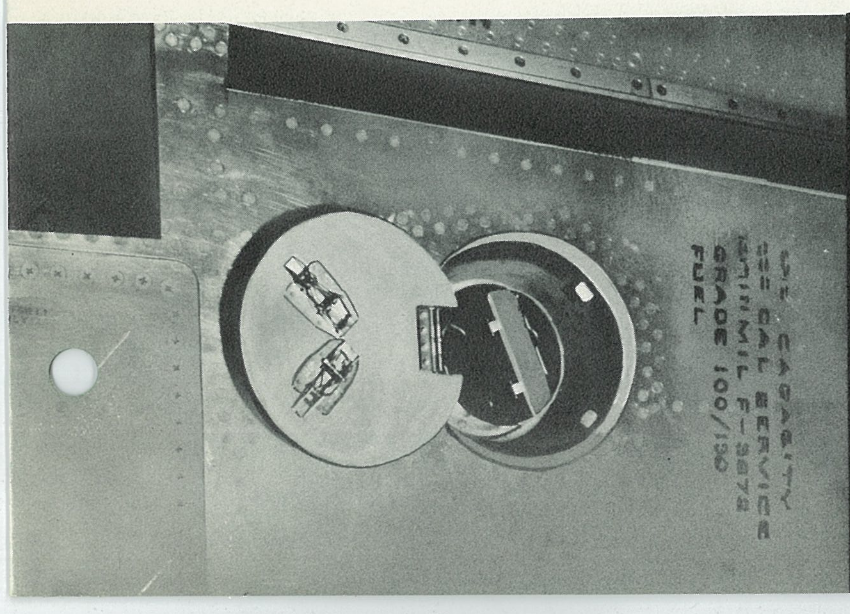
On the Model 240, a fuel quantity indicator is located on the instrument panel, in addition to the dipstick on the filler cap. On Models 340 and 440, each wing tank incorporates two direct-reading float-type gages mounted in the lower surfaces of the wing. The outboard gages indicate from 375 to 675 gallons, and the inboard gages indicate from 75 to 400 gallons. These gages are used only as a check during fueling. Fuel quantity gages in the cockpit indicate the quantity of fuel in pounds which, due to varying density of gasoline, is a more accurate measurement.

Fuel capacity of the Model 240 is 1000 gallons (+ 3 per cent expansion space) without outer panel tanks, and 1530 gallons if outer panel tanks are installed. Fuel capacity for the Models 340 and 440 is 1730 gallons, plus 3 per cent expansion space.

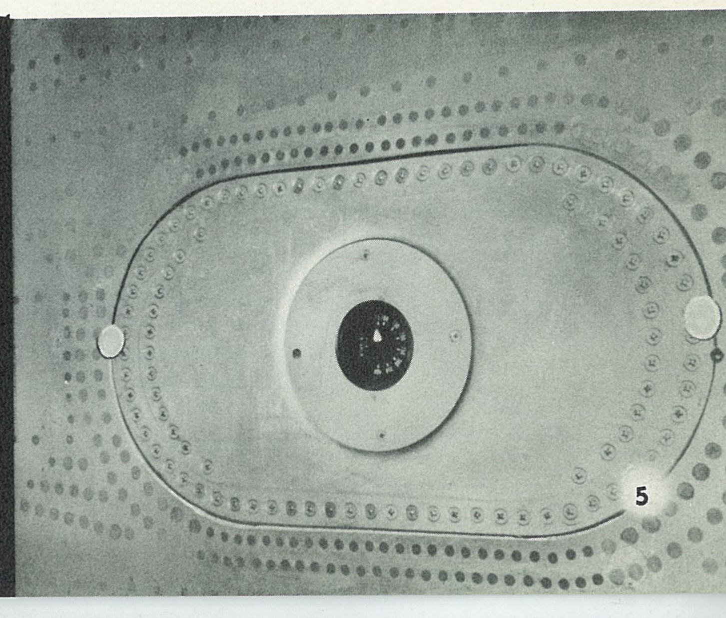
When filling or draining the fuel tanks, the following precautions should be observed in order to avoid any condition that could cause ignition of gasoline or of its fumes.

1. Accomplish all filling or draining operations out-of-doors whenever possible.
2. Prohibit smoking within 50 feet of the airplane.
3. Observe all necessary precautions to avoid spilling or splashing of fuel on personnel or in the area.
4. Do not permit personnel to enter area if they are wearing cleats or hobnail boots, since these constitute a fire hazard when scraped on concrete.
5. Do not service an airplane with fuel while radio or radar transmitting equipment is in operation.
6. Do not handle fuel within a radius of 75 feet of radio or radar equipment when it is in operation.
7. Check to be certain that the static chains of fuel trucks and trailers make good electrical contact with the ground.
8. Create a good electrical bond between the airplane and ground. This bond consists of a flexible wire that is permanently attached to the fuel discharge nozzle. The other end of the bonding wire is equipped with a standard test clip. Attach the clip to the fueling ground jack on the lower surface of the leading edge, below the filler neck opening.
9. Do not remove the fuel filler cap from the tank until after the delivery nozzle has been bonded to the jack.
10. Reinstall the fuel filler cap before the delivery nozzle bonding wire is detached from the jack.

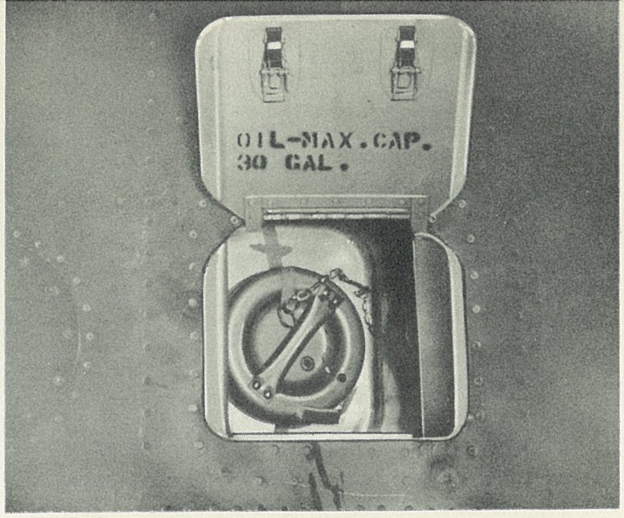
Fuel Tank Filler Cap (340)



Direct-Reading Float Type Fuel Gage Inboard (340-440)



Oil Tank Filler Cap
340-440



OIL SERVICING TANK

Convair 240 oil tanks are located on the right-hand side of each nacelle. Each tank has a usable capacity of 22.5 gallons with a foaming and expansion space of approximately 2.5 gallons. Oil, Spec. S.U.S. 100-120 at 210°F is recommended. The oil tank filler neck is accessible after removal of the filler cap. The filler neck is equipped with a removable screen which has a flow capacity of 18 gallons per minute at 87°F.

On Models 340 and 440, a tank with a displacement of 35 gallons is located in the top center of each nacelle between the augmentor tubes. Sufficient expansion space (approximately three gallons) is left after filling the tank to the upper lip of the filler neck. Of the 32 gallons which constitute the normal fluid content of each tank, 2.0 gallons is a reserve for propeller feathering, leaving a balance of 30.0 gallons available for engine use. The filler neck, located near the top on the right-hand side of each nacelle, is equipped with a removable screen with a flow capacity of 18 gallons per minute at 87°F. Oil, grade S.U.S. 100-120 at 210° F is recommended for use.

During winter operation, when it is necessary to service the oil tanks, it should be done prior to dilution, and in accordance with the CAA Approved Flight Manual.

ADI TANK

A water injection system tank with a capacity of approximately 22.5 gallons is installed in the right wing-fuselage fairing of all Convair-Liners. The ADI system may be filled through a gravity filler in the top of the right-hand wing-fuselage fillet, or through a pressure filler connection, accessible through a hinged door beneath the wing. The tank on all models has a capacity of 22.5 gallons with a usable quantity of 22 gallons.

The ADI fluid is a mixture of distilled water and alcohol. Water-alcohol solutions may vary according to operating conditions or to availability of different types of alcohol. The engine manufacturer recommends a solution of 50% methyl alcohol and 50% water by volume; or as an alternate mixture, 25% ethyl alcohol, 25% methyl alcohol, and 50% water.

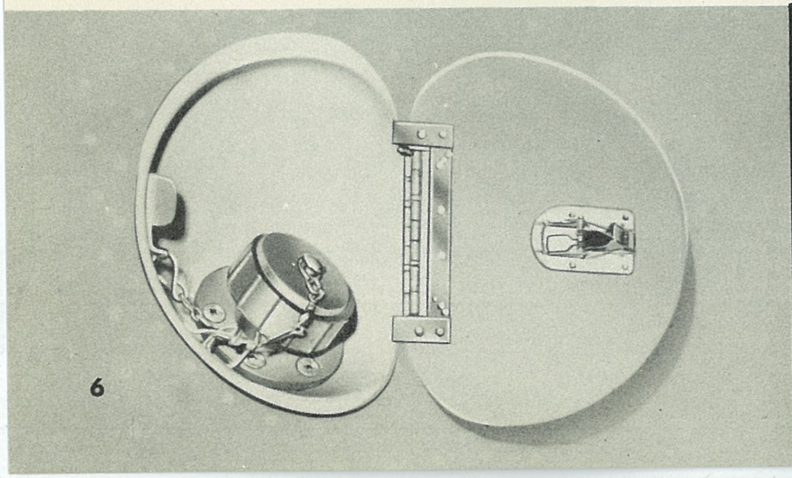
Only distilled water should be used, and the solution should be thoroughly agitated and then filtered through a 10-micron filter before filling the ADI tank.

PRECAUTIONARY NOTES

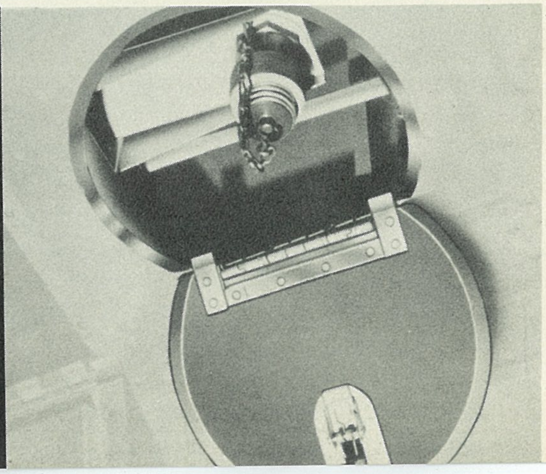
1. Avoid unnecessary direct contact with ADI mixtures, and inhalation of vapors because the cumulative toxic effects may be serious.

2. ADI solutions are highly flammable. Use same general precautionary measures used in handling aviation fuels.

ADI Gravity Fill Connection
on Top of Wing-Fuselage Fillet



ADI Pressure Fill Connection
on Bottom of Wing



HYDRAULIC RESERVOIR

On each of the three versions of the Convair 240, the hydraulic reservoir has a different location. On most of the Convair 240's, the reservoir is located aft of station 109 on the right-hand side of the airplane, outboard of the crew locker. On this version, the reservoir is replenished from outside the airplane, through an access door just forward of the main entrance door. On others, the reservoir is located at station 120, right-hand side in the radio-cargo compartment, or at station 120, left-hand side, just aft of the pilots' compartment. On these latter two versions, the reservoir is filled from inside the airplane, the filler opening being accessible after removal of the panel. The reservoir is filled to the level marked "FULL (GROUND LEVEL, GEAR DOWN, ACCUM 3000 PSI)".

The hydraulic reservoir in Convair 340's and 440's is located at the left side of the pilots' compartment, just aft of the pilot's seat. The reservoir has a total capacity of 9.5 U.S. gallons of which 3.5 gallons represents foaming space. Of the 6.0 gallons which constitute normal fluid content of the reservoir, 2.5 gallons is a reserve supply for use with the electric-driven emergency pump system, leaving a balance of 3.5 gallons available for normal use.

The reservoir is replenished through a filler spout in the top. A transparent tube gage is installed on the side of the reservoir and is visible from the pilots' compartment. The gage is calibrated for GROUND LEVEL FULL, GROUND LEVEL REFILL, FLIGHT LEVEL FULL, and FLIGHT LEVEL REFILL.

The reservoir should be replenished if fluid level is below "GROUND LEVEL FULL" mark on gage.

An alternate method of filling 240 and 340 reservoirs may be employed by placing the hydraulic bypass control in "bypass" and pumping fluid from a ground unit through the hydraulic pressure connection in the nose wheel well.

A third method of replenishing systems of 240, 340, and of the 440 aircraft is through the suction fitting in the nose wheel well. If this method is used, proceed as follows:

1. Connect a hand-operated hydraulic test pump with micronic filter to ground-test suction fitting.

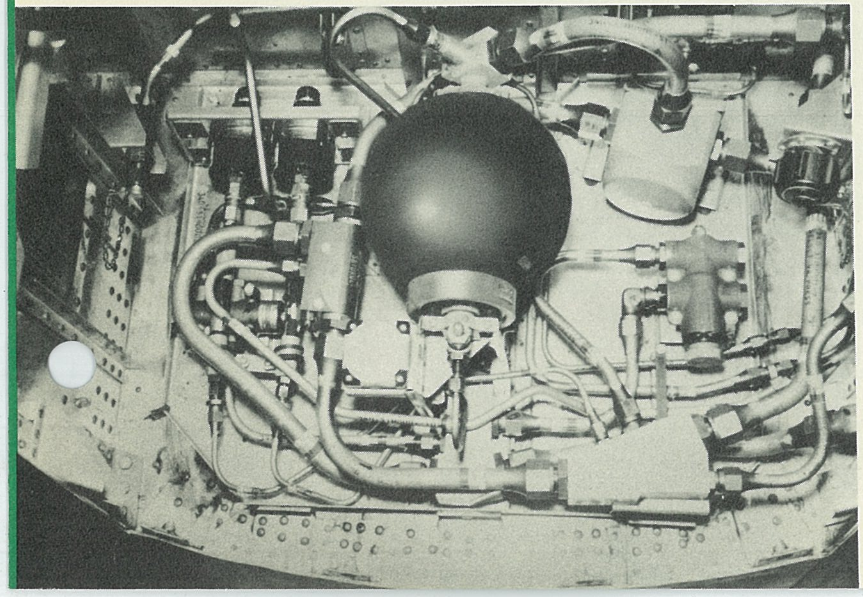
2. Station a man at sight gage and fill the reservoir to the "GROUND LEVEL FULL" mark with clean hydraulic fluid.

3. Disconnect ground test stand and secure cap fitting.

On Convair's 440's, the system may be replenished at the case drain line on the outboard side of either pump.

CAUTION

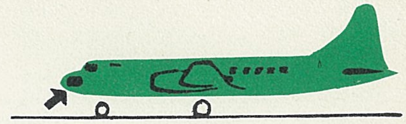
Before filling the main hydraulic system fluid reservoir, check for fluid identification placards. Mineral base fluids, such as AC3580, MIL-O-5606, and Shell 1AC should not be mixed with Skydrol, and Skydrol should not be used in equipment unless specifically placarded for its use.



HYDRAULIC ACCUMULATOR

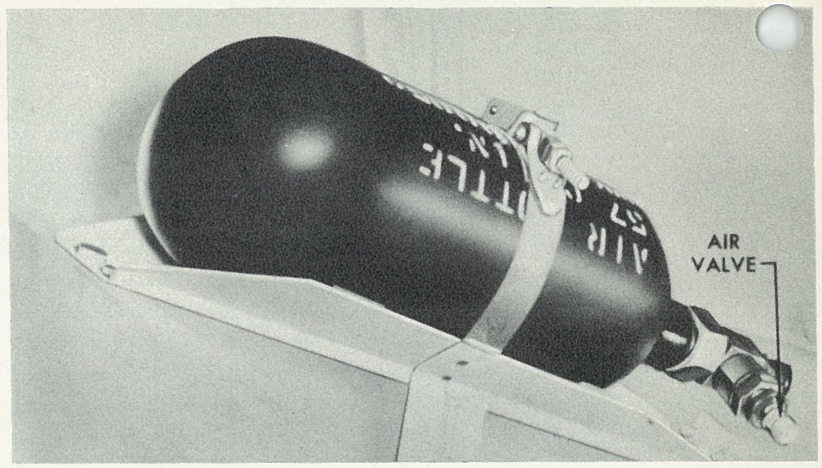
The hydraulic accumulator on all Convair-Liners is located in the nose wheel well compartment on the airplane center line at station 109. The accumulator is charged with compressed air or dry nitrogen to a pressure of 1000 psi. A direct-reading pressure gage is located in the nose wheel well, adjacent to the accumulator.

Hydraulic Accumulator
240-340-440



EMERGENCY AIR BRAKE BOTTLE

The air bottle is located on the left side of the nose wheel well just aft of the nose wheel fairing door on all Models of the Convair-Liner. The bottle is charged to 2000 psi with nitrogen or compressed air. A direct-reading gage is located in the pilots' compartment.



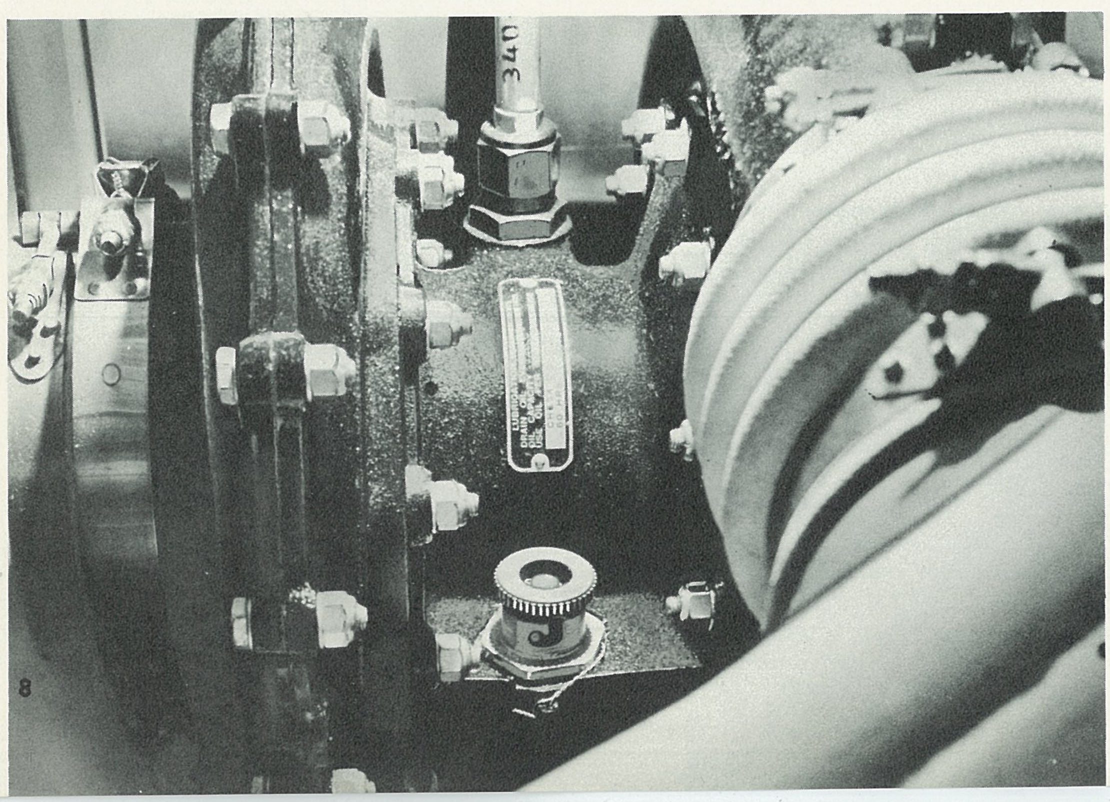
Emergency Air Brake Bottle
240-340

SECONDARY COMPRESSOR AND EXPANSION TURBINE

On Convair 240's, the secondary compressor and expansion turbine for the air-conditioning system is located at the bottom of the fuselage on the center line at station 510. The unit is located in the same general area on Models 340 and 440. A common sump with a capacity of 940 cc (approximately 500 cc on 340 and 440) serves both the secondary compressor and the expansion turbine. Access to the filler opening is through a door on the airplane center line below the unit. A dipstick is attached to the filler cap.

Due to the high speed at which the unit operates, a frequent check of the oil level is necessary. The unit is replenished with hydraulic oil to the "MAXIMUM" mark on the filler cap dipstick. The fluid used depends on airline requirements; however, before filling, fluid identification placards should be checked to determine if mineral base fluids or Skydrol are required. *Only the type fluid specified should be used.*

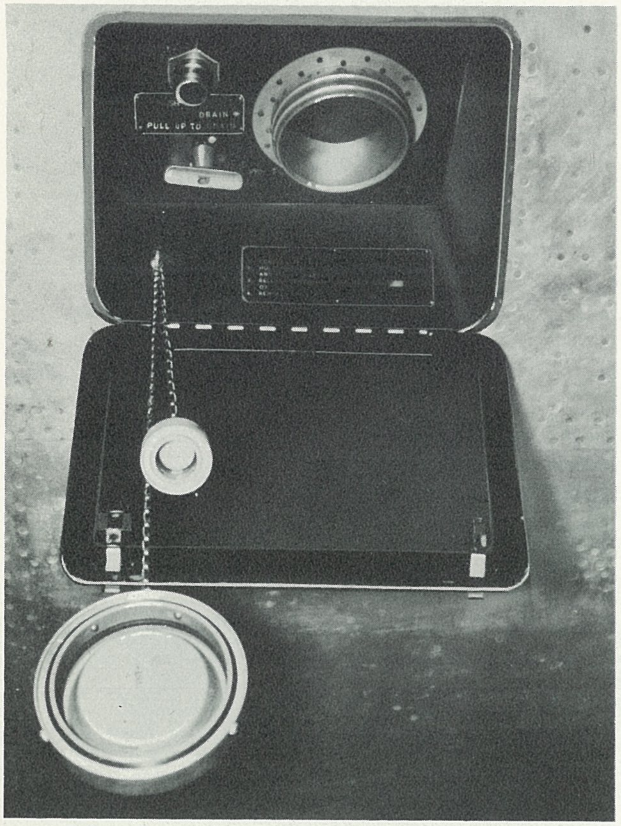
Filler Connection for Secondary Compressor
and Expansion Turbine 340-440



FRESH WATER AND SEPTIC TANKS

On all Convair-Liners, the utility water tank is located in the aft cargo compartment. The tank is filled through a filler connection on the lower left-hand side of the fuselage just below the tank. Access is through a hinged door. When filling, Roylyn caps are removed from both the filler and overflow connections, and a filler hose attached to the filler connection. The tank is replenished with fresh water. The design capacity of the tank is ten gallons, but overflow standpipes in some tanks limit the capacity to 5 to 7 gallons. Water will flow in a steady stream from the overflow connection when the tank is filled to its predetermined capacity.

Waste water tanks on all Convair-Liners are located directly below the lavatory installation. In all installations, the tank is drained by connecting a hose to the drain connection, and by pulling the drain handle. A flush hose is then connected to the flush connection and the draining continued until drain handle is released. When draining is complete, the drain hose is removed. The tank is charged with approximately two gallons of water to which a disinfectant has been added.



Waste Water Tank Cleanout Panel

PRIMARY COMPRESSOR OIL SUMP

On Convair 240's, the primary compressor is located in the right wing center section trailing edge between the fuselage and nacelle. The sump is located on the bottom of the compressor case. Access to the sight gage and filler opening is through a door outboard of the compressor compartment, on the wing trailing edge. Capacity of the sump is approximately two gallons, the system and lines holding approximately five gallons. The sump is replenished with hydraulic fluid, using nameplate adjacent to gage as guide to oil specification.

On Convair 340's and 440's, the primary compressor is attached to the upper right accessory drive pad on the right-hand engine; the oil tank sump for the compressor is in the left side of the right-hand nacelle. The tank usable capacity is approximately two gallons when filled level with the bottom of the filler neck. The tank is filled to bring the level to the 1.5-gallon mark on the dipstick. The compressor drain plug and reactor valve fitting are accessible through the right main landing gear wheel well and firewall access door.

Before filling the compressor, the power pressure line from the reactor valve fitting should be disconnected and the compressor drain plug removed. Using a hand pump equipped with a micronic filter, fluid should be added to the compressor system through the reactor valve fitting until fluid, free of air bubbles, flows from the compressor drain hole. The right-hand engine should be operated approximately five minutes to circulate fluid through the system.

LANDING GEAR

MAIN AND NOSE GEAR STRUTS. To service both the main and nose gear shock struts of Convair 240, 340, and 440 aircraft, refer to servicing charts on pages 10 and 11.

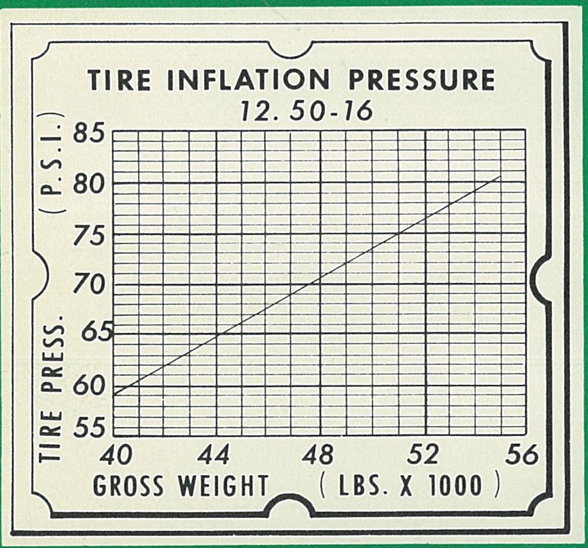
TIRES. Tire service life can be extended if established tire pressures are maintained. This necessitates checking tire pressures at least once a week. Newly mounted tires should be checked daily for several days after which the regular inflation schedule may be followed. If either or both of the inboard main landing gear tires show undue wear as a result of runway crown, it is advisable to decrease the pressures in these tires by 5 psi in order to reduce and equalize wear.

Over-inflation to offset overloading is not recommended because increased tension and strain on the tire cords may not provide sufficient stretch to absorb landing shocks. Tread and sidewall rubber under excessive tension make tires more susceptible to cuts, and increase tendency to enlarge existing cuts. Tires that are under-inflated have a tendency to creep or slip on the wheels when landing or when brakes are applied, and there is a possibility that the sidewalls will be pinched by the rim. Under-inflation will cause uneven wear along or near the edge of the tire.

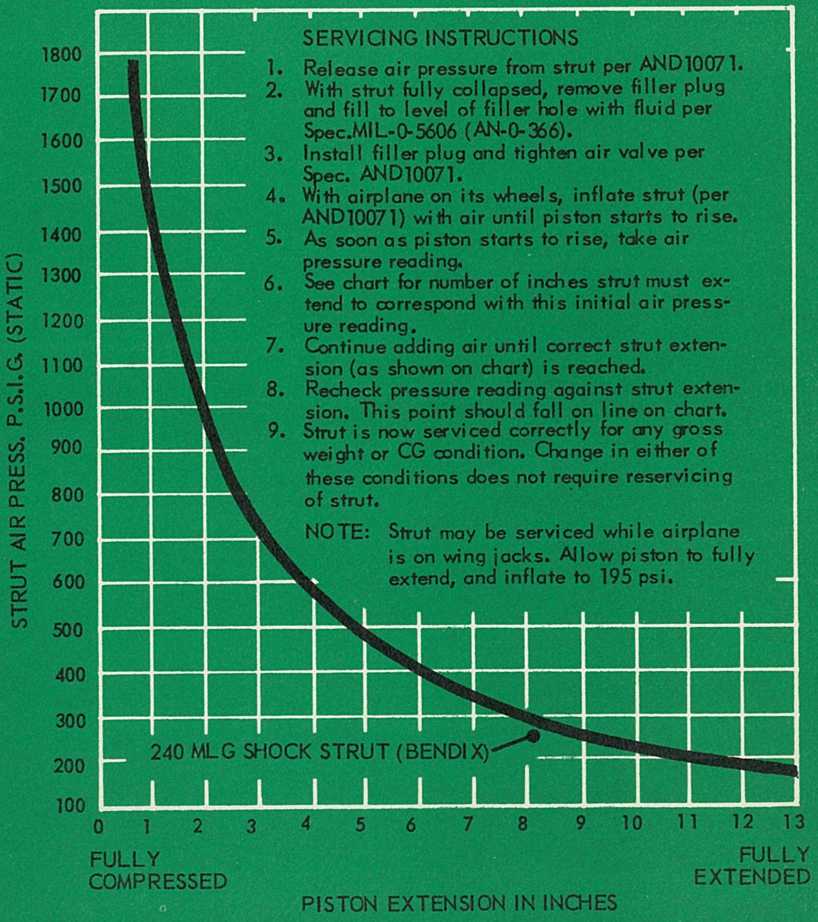
When replacing a nose landing gear tire, it is important that a tire worn to approximately the same degree as the other tire be installed. *Do not install a new nose gear tire opposite one from which nearly all the tread has been worn.*

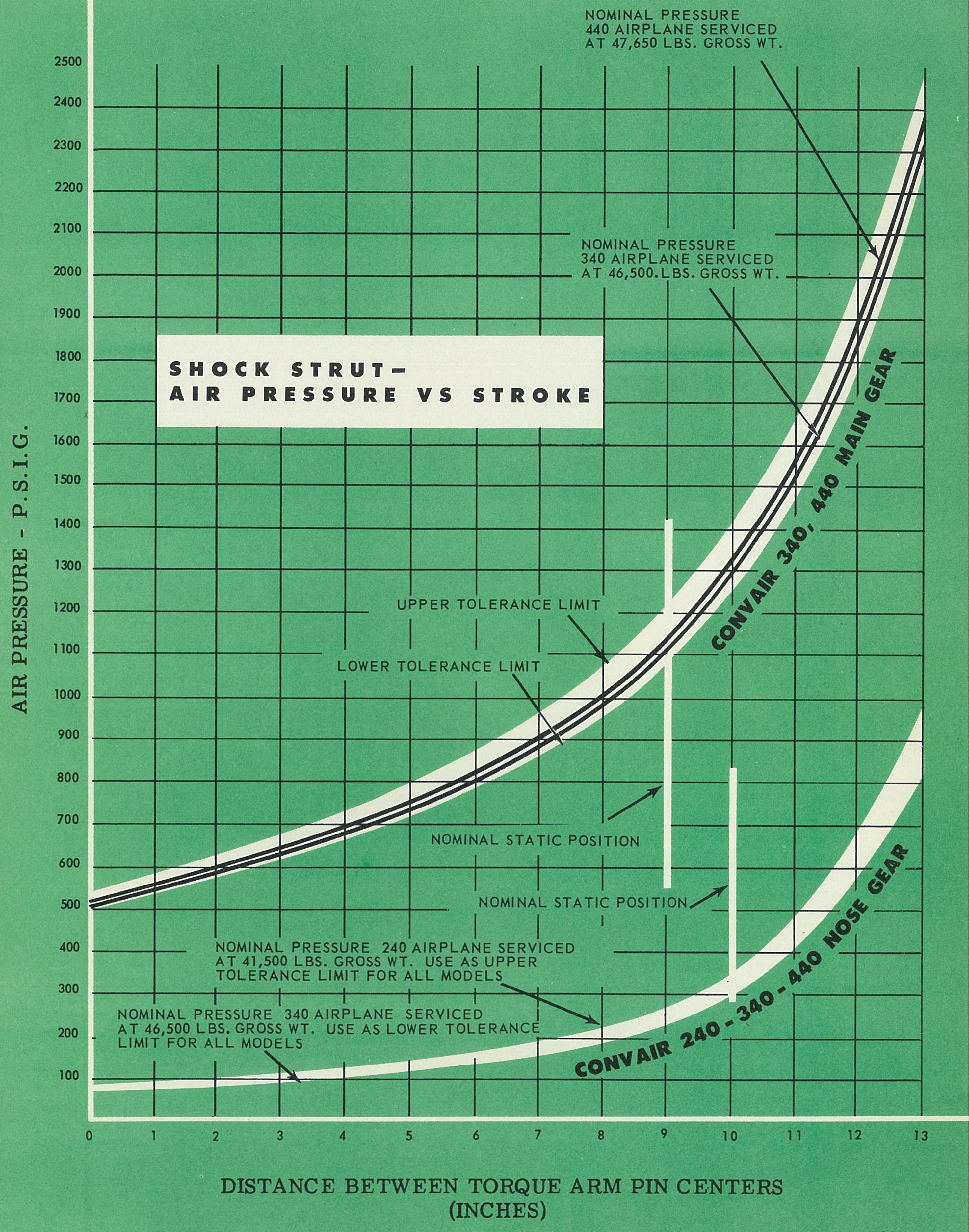
Nose gear tire pressure is stenciled inside the nose wheel well door.

Main gear tires are inflated in accordance with a placard installed inside the door of the right main wheel well. Information on this placard is reproduced on this page. Airline operation indicates that better tire life can be obtained if main landing gear inboard tires are inflated 5 psi less than the outboard tires.



STRUT PRESSURE VS PISTON EXTENSION




SHOCK STRUT–
AIR PRESSURE VS STROKE
AIR PRESSURE - P.S.I.G.
2500
2400
2300
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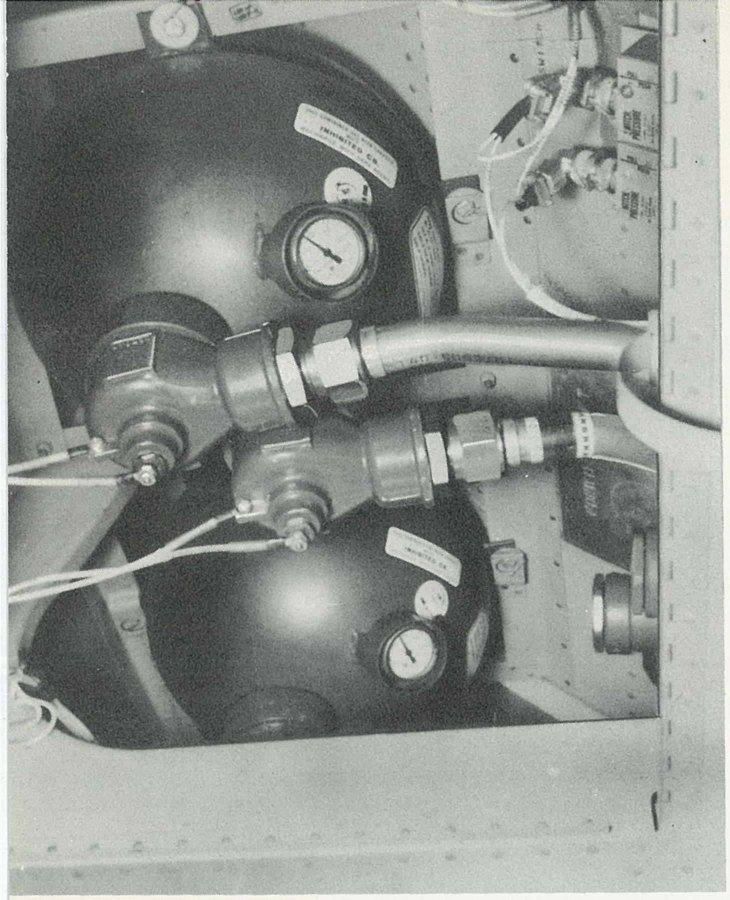
NOMINAL PRESSURE
440 AIRPLANE SERVICED
AT 47,650 LBS. GROSS WT.
NOMINAL PRESSURE
340 AIRPLANE SERVICED
AT 46,500. LBS. GROSS WT.
CONVAIR 340, 440 MAIN GEAR
UPPER TOLERANCE LIMIT
LOWER TOLERANCE LIMIT
NOMINAL STATIC POSITION
NOMINAL STATIC POSITION
NOMINAL PRESSURE 240 AIRPLANE SERVICED
AT 41,500 LBS. GROSS WT. USE AS UPPER
TOLERANCE LIMIT FOR ALL MODELS
NOMINAL PRESSURE 340 AIRPLANE SERVICED
AT 46,500 LBS. GROSS WT. USE AS LOWER TOLERANCE
LIMIT FOR ALL MODELS
CONVAIR 240 - 340 - 440 NOSE GEAR
DISTANCE BETWEEN TORQUE ARM PIN CENTERS
(INCHES)



CB Fire Extinguishing Spheres
340-440

POWER PLANT FIRE EXTINGUISHING SYSTEM

On Convair 240's, there are four CO_2 cylinders in the fire extinguishing system, two for the main supply and two for the reserve supply. All cylinders are accessible through the forward door of the lower cargo compartment. They are located on the left-hand side of the airplane — the two main cylinders forward of the door, and the reserve cylinders aft of the door. On some airplanes, the capacity of each bottle is 12.6 pounds; on others, it is 7.24 pounds. The bottles are removed from the airplane for recharging. Bottles are charged with CO_2 until proper weight as specified has been obtained.

Convair 340's and 440's use Chlorobromomethane (CB) in the fire extinguishing system. Two 630-cubic inch spheres, each with a capacity of 22.50 pounds of CB, and charged with nitrogen to a pressure of 400-440 psi, are located in the left-hand wing fillet, where they are easily accessible through a door in the lower surface of the fairing. The C-B container incorporates a built-in pressure gage, temperature safety seal (which relieves at 208 to 220°F) and electrically-operated discharge bonnet. The C-B container is factory charged and sealed. Outlets and discharge cartridges may be installed without disturbing the container seal.

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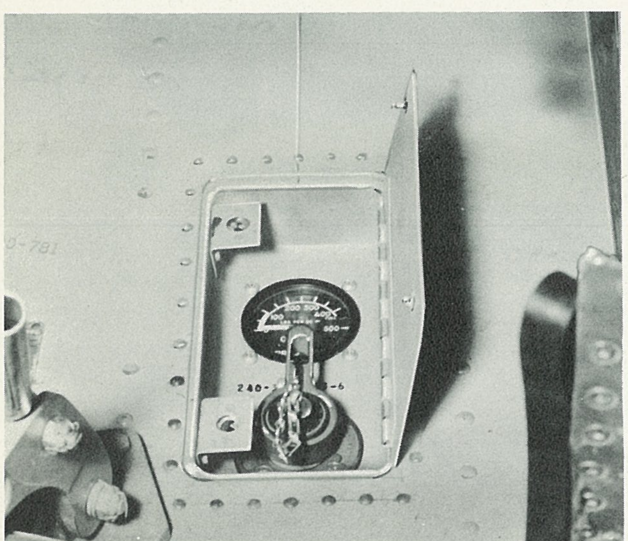
OXYGEN SYSTEM

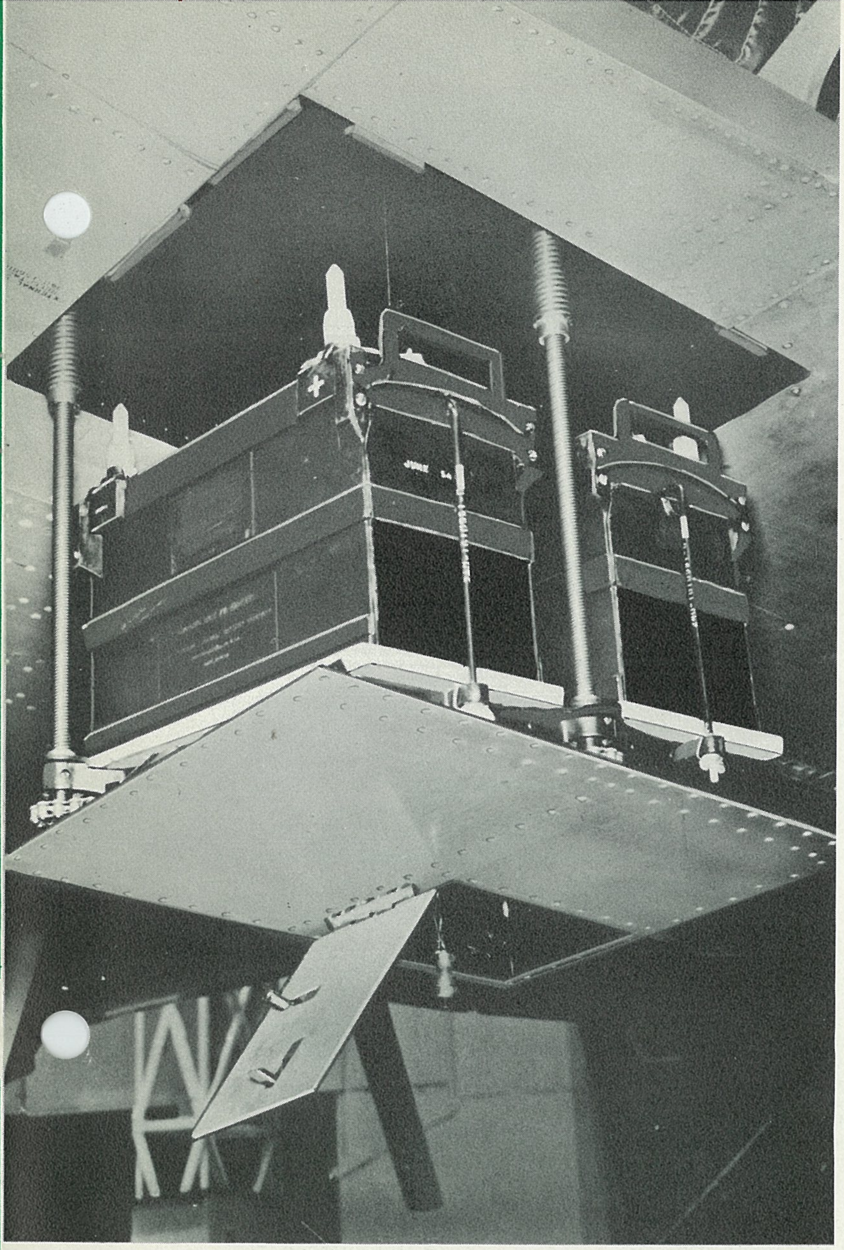
On some Convair 240's and 340's, and on the 440, a high-pressure oxygen system is utilized. The high-pressure bottle is located aft of the copilot in the pilots' compartment. The cylinder has a capacity of 48.3 cubic feet (38.4 cubic feet on some 340's). The cylinder is removed from the airplane and charged with oxygen, Specification BB-O-925, to a pressure of 1800 psi (1200 to 1800 psi on 38.4 cubic foot bottle).

On those Convair 240's which utilize the low-pressure system, two different installations are used. On some airplanes, three cylinders are installed under the floor between stations 569 and 587; on others, one cylinder is installed in the same general area on the airplane center line. Access to the filler opening on each of these two versions is through a door on the bottom of the fuselage at station 597. If pressure has dropped below 350 psi, the cylinders should be charged with oxygen, Specification BB-O-925, to a pressure of 400 psi.

On Convair 340's which utilize a low-pressure system, an oxygen cylinder with a capacity of 28 cubic feet is installed on the aft right-hand side of the pilots' compartment under the copilot's console. The filler connection and gage are located in the right-hand side of the nose wheel well. The cylinder is charged to 400 psi with oxygen, Specification BB-O-925.

Low-Pressure Oxygen Filler Cap and Gage (340)





Battery Elevator in Left Wing Trailing Edge

BATTERY

On most models of the Convair-Liner, an elevator in the left wing trailing edge is provided for a battery or batteries. The elevator is lowered and raised by means of a crank inside an access door on the forward inboard side of the elevator. Access to the battery is gained by lowering the elevator, the base of which forms a door on the lower surface of the left wing trailing edge between the nacelle and fuselage.

The battery is filled with distilled water, using a self-leveling syringe. Level of electrolyte should be 3/8 inch above the protector plate.

CAUTION

Exercise care to prevent spilling of battery acids. Trays are lined with felt that is saturated with a sodium bicarbonate solution to prevent corrosion of the battery tray.

On some Convair 240's, the battery is located aft of station 109 in the entrance compartment, left side. Access is through a door at station 131, just above the floor level. Care should be exercised to prevent spilling battery acids on interior trim materials. If acid should come in contact with materials, the spot should be treated immediately by sponging with a dilute solution of household ammonia. After ammonia water has had opportunity to neutralize, the area should be thoroughly rinsed with cold water.

REPLENISHING CHARTS CONVAIR LINER 240

UNIT	LOCATION	CAPACITY	FILLER CAP	REPLENISH WITH	SPECIAL INSTRUCTIONS
Fuel Tank with Outer Panel Tanks	Between wing stas 8 & 15, 17 & 27	1530 gals.	On wing upper surface near leading edge	See applicable paragraph in text	See applicable paragraph in text.
Fuel Tank without Outer Panel Tanks	Between stas 8 & 15	1000 gals.			
Oil Tank	RH side of each nacelle	22.5 gals. each + 2.5 gals. expansion space	On RH side of each nacelle under hinged door	Oil, S.U.S. 100-120 at 210°F.	Dipstick accessible after removal of cap. See applicable paragraph in text for additional instructions.

UNIT	LOCATION	CAPACITY	FILLER CAP	REPLENISH WITH	SPECIAL INSTRUCTIONS
Hydraulic Reservoir	Aft of Sta 109, RH side, outbd of crew locker	6.0 U. S. gals. + 3.5 gals. expansion space	Access door fwd of M. E. door	As placarded	Fill to level marked "FULL (GROUND LEVEL, GEAR DOWN, ACCUM 3000 PSI). See applicable paragraph in text for pressure filling.
	Sta 120 RH side, in radio-cargo compt Sta 120, LH side, aft of pilots' compt		Filler cap under access panel adjacent to reservoir. Fill from inside airplane		
Hydraulic Accumulator	Nose wheel well compt	1000 psi	Bottom of accum	Charge with 1000 psi of compressed air or dry nitrogen	Direct-reading pressure gage is located in nose wheel well.
Emergency Air Brake Bottle	LH side of nose wheel well, aft of NLG fairing door	2000 psi	Fwd end of bottle	Charge with dry nitrogen or compressed air to 2000 psi.	Direct-reading gage in pilots' compt
Secondary Compressor & Expansion Turbine	Bottom of fuselage on CL at sta 510	940 cc	Fwd LH side of unit	As placarded	Fill to MAXIMUM mark on filler cap dipstick.
Primary Compressor Oil Sump	RH wing center section between fuselage and nacelle	2 gals.	Through door outbd of compressor compt on wing trailing edge	As placarded	Use nameplate adjacent to gage as guide for filling.
Battery	Left wing trailing edge	See special instructions	Top of battery. Access by lowering battery by means of crank behind door in elev panel.	Distilled water	Use self-leveling syringe until electrolyte is 3/8 inch above protector plate.
	Aft of station 109 in entrance compt		Access through door at sta 131, above floor level		
Oxygen Cylinders 1 High-Pressure	In pilots' compt aft of copilot	48.3 cu ft	At top of cylinder	Oxygen, Spec BB-O-925	When pressure drops to 1700 psi, charge to 1800 psi. Remove from airplane for charging.
1 Low-Pressure 3 Low-Pressure	Under floor on CL between stas 569 and 587	31.8 cu ft	Through door on bottom of fuselage at sta 597		When pressure drops to 350 psi, charge to 400 psi.
Power Plant Fire Extinguishing System Cylinders (4)	In lower cargo compt, fwd and aft of fwd door	12.6 cu ft or 7.24 cu ft	Remove cylinders from airplane and replenish. Accessible through fwd door of lower cargo compt.	CO_2	Charge with CO_2 until proper weight as specified has been obtained.
ADI Tank	RH Wing-Fuselage Fillet	22.5 gals.	Gravity filler on top of fillet; pressure filler on bottom of wing.	Mixture of distilled water and alcohol. See applicable paragraph in text.	See applicable paragraph in text.
Fresh Water Tank	Aft Cargo Compt	10-gallon tank. Capacity limited by standpipe.	Lower LH side of fuselage under buffet.	Fresh water	See applicable paragraph in text for additional information.
Waste Water Tank	Under lavatory	Approx 22 gals.	Lower RH side of fuselage under lavatory.	2 gals of water to which disinfectant has been added.	See applicable paragraph in text for additional information.
Landing Gear Tires	See applicable paragraphs in text for inflation of main and nose landing gear tires.				
LG Shock Struts	See charts in text for servicing instructions.				

REPLENISHING CHART CONVAIR-LINER 340, METROPOLITAN 440

UNIT	LOCATION	CAPACITY	FILLER CAP	REPLENISH WITH	SPECIAL INSTRUCTIONS
Fuel Tank	Between wing stas 8 & 29	1730 gals. + expansion space	Wing leading edge-upper surface	See applicable paragraph in text	See applicable paragraph in text.
Oil Tank	Top of nacelle between augmentor tubes	32.5 + 3 gals. expansion space	Near top on RH side of each nacelle	Oil, S.U.S. 100-120 at 210°F.	See applicable paragraph in text.
Hydraulic Reservoir	LH side of pilots' compt, aft of pilot's seat	9.5 U. S. gals.	Filler spout in top of reservoir. See applicable paragraph in text for pressure filling.	As placarded	Before filling, check for Skydrol placards. Other fluids should not be mixed with Skydrol.
Hydraulic Accumulator	Nose wheel well	1000 psi	Bottom of unit	1000 psi of compressed air or dry nitrogen	Direct-reading pressure gage located adjacent to unit.
Emergency Air Brake Bottle	LH side of nose wheel well, aft of NLG fairing door	2000 psi	Fwd end of bottle	2000 psi of compressed air or dry nitrogen	Direct-reading gage in pilots' compt.
Secondary Compressor & Expansion Turbine	Bottom of fuselage at sta 510	Approx 500 cc	Fwd LH side of unit	As placarded. Do not mix fluids.	Dipstick is attached to filler cap. Fill to MAXIMUM mark.
Primary Compressor Oil Tank	LH side of RH nacelle	2 gals.	In RH MLG wheel well, through firewall access door	As placarded. Do not mix Skydrol & mineral - base fluids.	See applicable paragraphs in text for additional information. Fill to 1.5-gallon mark on dipstick.
Battery	Left wing trailing edge	See Special Instructions	Accessible after lowering battery by means of crank behind door in elevator panel.	Distilled water	Use self-leveling syringe until electrolyte is 3/8 inch above protector plate.
Oxygen Cylinders					
High-Pressure	Aft of copilot	48.3 cu ft	Top of bottle	Oxygen, Spec BB-O-925	When pressure drops to 1700 psi, charge to 1800 psi. Remove from airplane for charging.
		38.4 cu ft			Charge to 1200 to 1800 psi.
Low-Pressure	Under console outbd of copilot's seat	29 cu ft	Nose wheel well, RH side		Charge to 400 psi.
Power Plant Fire Extinguishing System Spheres	LH wing fillet	Two 630-inch spheres with capacity of 22.50 lbs each	See Special Instructions	CB charged with nitrogen to a pressure of 400-440 psi.	Containers are factory-charged.
ADI Tank	RH wing-fuselage fillet	22.5 gals.	Gravity filler on top of fillet; pressure filler on bottom of wing.	Mixture of distilled water and alcohol. See applicable paragraph in text	See applicable paragraph in text for additional information.
Fresh Water Tank	Aft cargo compt	10-gallon tank. Capacity limited by standpipe.	Lower LH side of fuselage under buffet.	Fresh water	See applicable paragraph in text for additional information.
Waste Water Tank	Under lavatory	Approx 22 gals.	Lower RH side of fuselage behind hinged door.	2 gals. of water to which disinfectant has been added	See applicable paragraph in text for additional information.
Landing Gear Tires	See applicable paragraphs in text for inflation of main and nose landing gear tires.				
LG Shock Struts	See charts in text for servicing instructions.				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CONVAIR

Traveler

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CONVAIR
Traveler

VOL. VIII NO. 2 JUNE 1956

FOREWORD

The spread of fire in Convair-Liner power plants is minimized by the use of stainless steel, which completely surrounds the engine and accessory compartments. Heat sensitive detectors have been placed at the airflow outlets and at other strategic locations to warn the pilot if fire exists in the power plant. Electrical wiring, fuel, oil, and hydraulic lines have been constructed of fire-resistant material. Now, a high-rate-discharge (HRD) system employing Freon will give operators the most effective weapon yet devised against fire in the power plant. This combination of Freon and HRD fills every corner of the nacelle with a cloud of vapor which stifles the flame at its source.

Included in this issue is information on the various types of fuel suitable for use with CB16 and CB17 engines.

ON THE COVER

The twin spheres are not spaceships but they do contain the latest thing in fire-fighting chemicals. The new Freon agent combined with high-rate-discharge delivery techniques is looming as large in the industry as it is on Jack Davis' cover.

C O N V A I R
A DIVISION OF GENERAL DYNAMICS CORPORATION
(SAN DIEGO)

A digest of Convair-Liner operation and service published monthly by the Service Publications Section of Convair in the interest of Convair-Liner operators. Communications should be addressed to Chief of Service, Convair, San Diego 12, Calif.

hrd+freon

IMPROVED FIRE PROTECTION FOR CONVAIR-LINER NACELLES

A new fire extinguishing system incorporating the principle of high rate discharge is being considered for Metropolitan 440's in production. HRD (High-Rate-Discharge), a new concept in fire extinguishing, has a much higher rate of effectivity than standard distribution systems in current use on aircraft.

The two most important factors in any agent distributing system are area distribution and rate of discharge. To be effective, an agent must be carried to the burning area rapidly and it must be distributed in sufficient quantities to smother the fire and prevent recurrence. The high-rate-discharge system has been thoroughly tested at Civil Aeronautics Administration laboratories in Indianapolis during the past several years. All test results indicate that it will satisfy requirements for rapid, effective distribution.

High rate discharge operates in much the same manner as does the present system used in 340 and 440 aircraft. When fire breaks out, heat sensitive thermocouples flash a warning in the cockpit; the pilot then feathers the propeller, actuates the fluid shutoff valve, and presses a button which fires a cartridge into the agent container. Pressure from the extinguishing agent closes a valve in the accessory compartment ventilating chimney, and forces agent into the accessory compartment and wheel well to extinguish the fire.

In the HRD system, agent enters the area at higher velocity; consequently, it reaches the burning area more rapidly and with greater force. This is achieved by the use of open nozzles in place of the perforated distribution rings used in a standard system.

The fire extinguishing system must have proper distribution proportions for wheel well and accessory compartments (1.5 of agent in the wheel well to 1.0 in the accessory area); and discharge within 0.5 to 1.0 seconds from time of actuation is also required.

A mockup of the proposed system was constructed to test the ability of HRD to meet these requirements. To check distribution proportions, water was passed through a proportionalizer manifold installation into weighing buckets. Diameter of the wheel well nozzle was varied until correct proportions were achieved.

Two 630-cubic-inch spheres used in the CB extinguishing system were used for the tests. Gage inserts were installed at the bottle discharge line and manifold to determine bottle pressure; a Brush recorder was set up at the manifold to measure line loss, rate of discharge, and nacelle vent door actuating pressure.

To test speed of discharge, the bottle was charged with 10 pounds of Freon 13B1, a new extinguishing agent developed by DuPont. Another identical bottle was charged with seven pounds of the agent. Then both bottles were pressurized to 400 psi with dry nitrogen.

All tests were recorded on motion picture film at 96 frames per second for discharge of the 10-pound bottle of agent and 65 frames per second for discharge of the seven-pound bottle. A black background was provided to accentuate discharge patterns, and a photographic flash bulb was connected to a synchronous circuit to illuminate simultaneously as the agent was discharged.

With the camera, pressure recorder, and timing clock in operation, a switch was thrown which simultaneously fired the cartridge to release the extinguishing agent, energized a flash bulb in the camera, and triggered a timing pin on the Brush recorder, thus coordinating camera and pressure recorder readings. Both camera and pressure recorder were operated until the agent was exhausted.

Test results revealed that agent was discharged from both bottles well within the CAA time requirement, but the 10-pound bottle provided an additional safety factor.

Convair research confirmed CAA studies on the HRD system and clearly demonstrated that installation of the new units provide a lighter weight fire extinguishing system and equivalent safety factors. Additional tests will be conducted on a 440 nacelle to further evaluate the merits of HRD and Freon, and, if results are satisfactory, the new improved design will be offered in kit form.

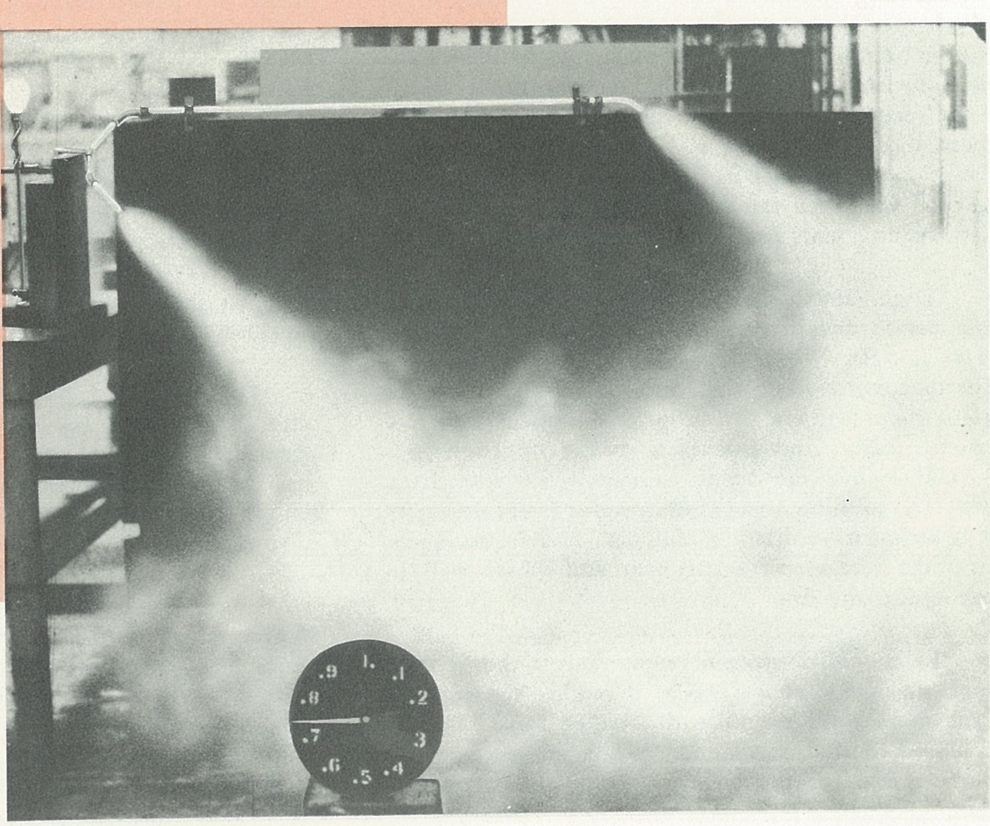
The modification will consist of removal of perforated distribution rings and all connecting tubing in the wheel well and accessory compartment. A proportionalizer manifold installation, bulkhead fittings and connecting supply line and tubing will be installed in the two compartments. The distribution rings will be replaced by open nozzles.

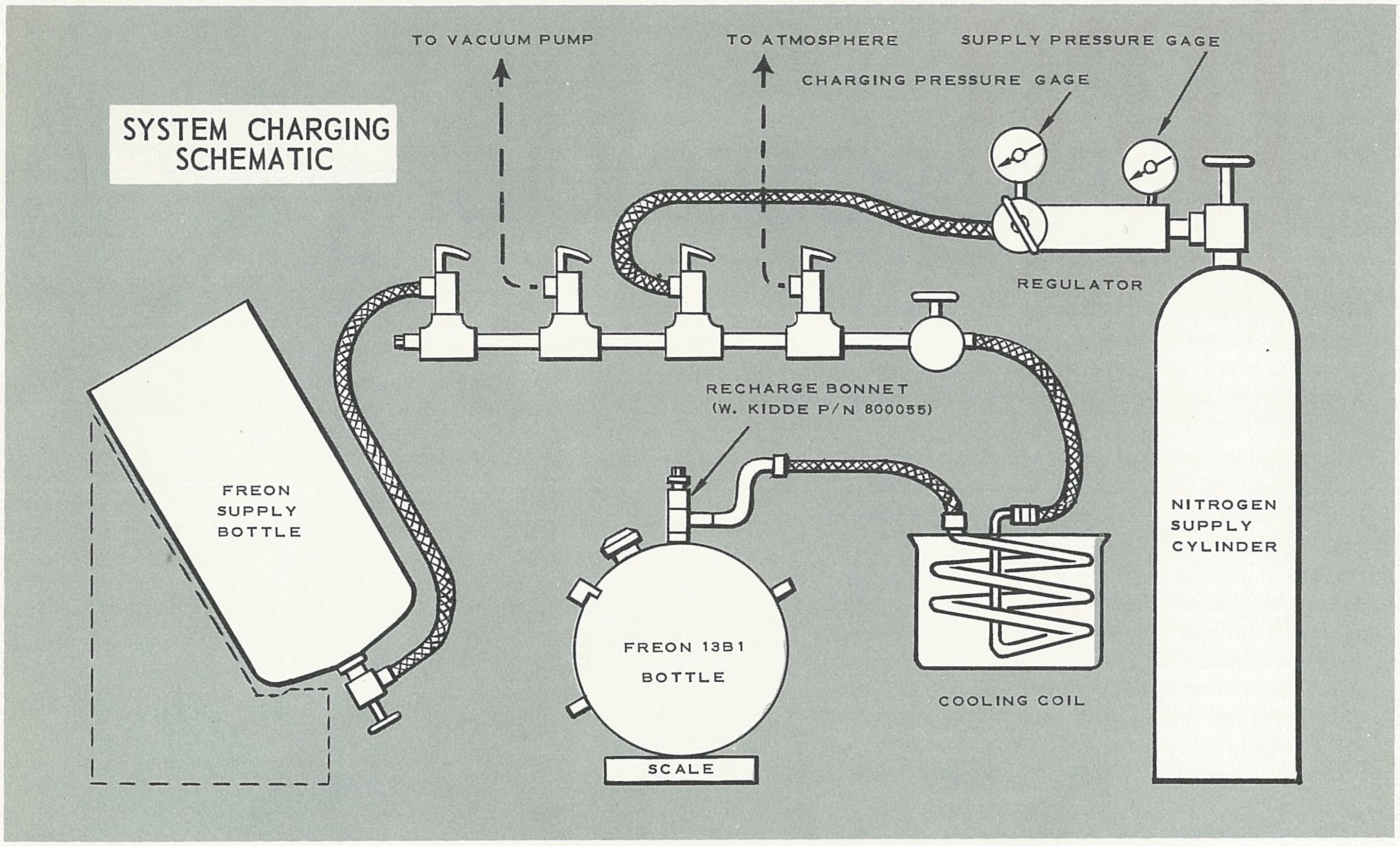
When CB is used in the HRD system, recharging procedures differ only slightly from those of standard systems, but the low boiling point and gaseous expansion rate of Freon 13B1 prevents the bottles from filling completely unless a cooling bath is added to the recharging process.

Walter Kidde Company's operating and servicing instructions on Freon 13B1 (CF_3Br) containers state that a standard CB recharging unit may be easily converted to Freon-HRD by the addition of a cooling coil, valve, three small fittings, and a short length of flexible hose. During recharging, the coil is placed in a dry ice, cracked ice, or similar cooling bath to lower agent temperature to the required 70°F.

Periodic inspection and maintenance procedures for agent bottles are approximately the same for HRD as for the standard distributing system if CB is used. The system should not, however, be used alternately for CB, Freon 13B1, and Freon 12B2 without a complete purging to drive out any remaining traces of the previously used extinguishing agent.

THE TIMING CLOCK AT THE BASE OF THE CONVAIR TEST STAND REGISTERS .75 SECOND AS FREON VAPOR FROM THE 10-POUND AGENT BOTTLE APPROACHES ITS FULL FLOW. THIS DEGREE OF DISTRIBUTION WAS REACHED HALF A SECOND AFTER THE FIRST VAPOR TRACES APPEARED AT THE NOZZLES.





EXTINGUISHING AGENTS

A fire extinguishing system is only as good as its agent. There are many effective agents, just as there are many types of fires, but a power plant fire extinguishing agent must be not only efficient, but also lightweight and easy to maintain. Carbon dioxide, used in Convair-Liner 240's, although an effective extinguishant, creates a severe weight problem because of the high-pressure cylinders and the large quantity of agent required. Carbon tetrachloride, one of the most commonly used extinguishing agents is corrosive, has considerable toxicity, and is relatively low in effectiveness. Its toxicity increases under conditions of extreme heat and, when it is directed at a power plant fire, it creates a cloud of toxic gas which may cause serious disability when it is used without protective equipment in a confined area.

Methyl bromide is one of the most effective agents available, but it is not recommended for use on Convair aircraft because of its high toxicity.

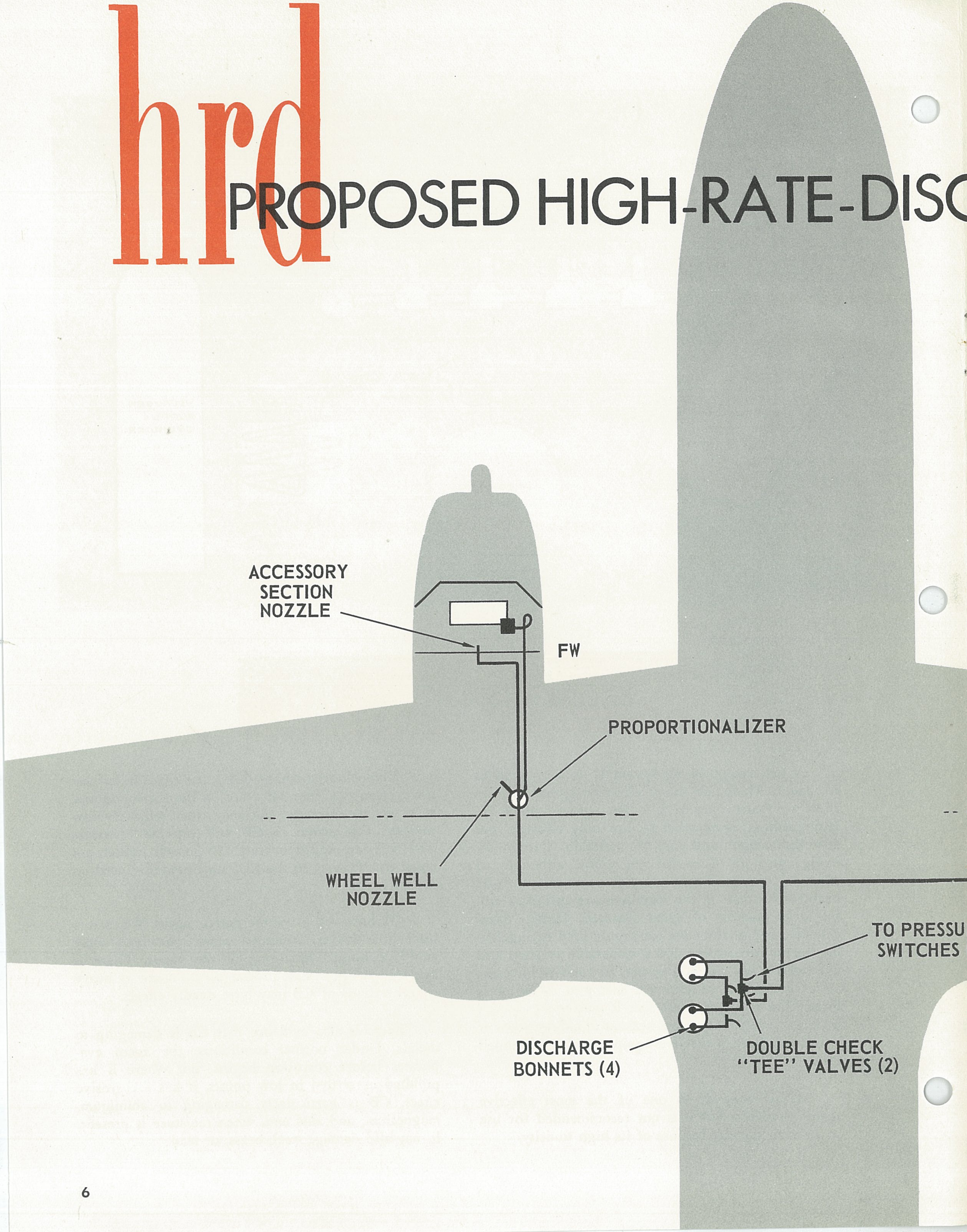
Bromochloromethane (CB), the agent in current use on Convair-Liner 340's and on the Metropolitans, was selected for its efficiency and relatively low toxicity. Conversion to CB will provide operators with a system approximately 150 pounds lighter, yet equal in efficiency to the CO_2 unit presently used on the 240.

CB, however, is not the perfect agent. When it is used in relatively confined areas, personnel must avoid prolonged breathing of the vapor. There is evidence to show that prolonged exposure to heavy concentrations of CB may have deadly effects.

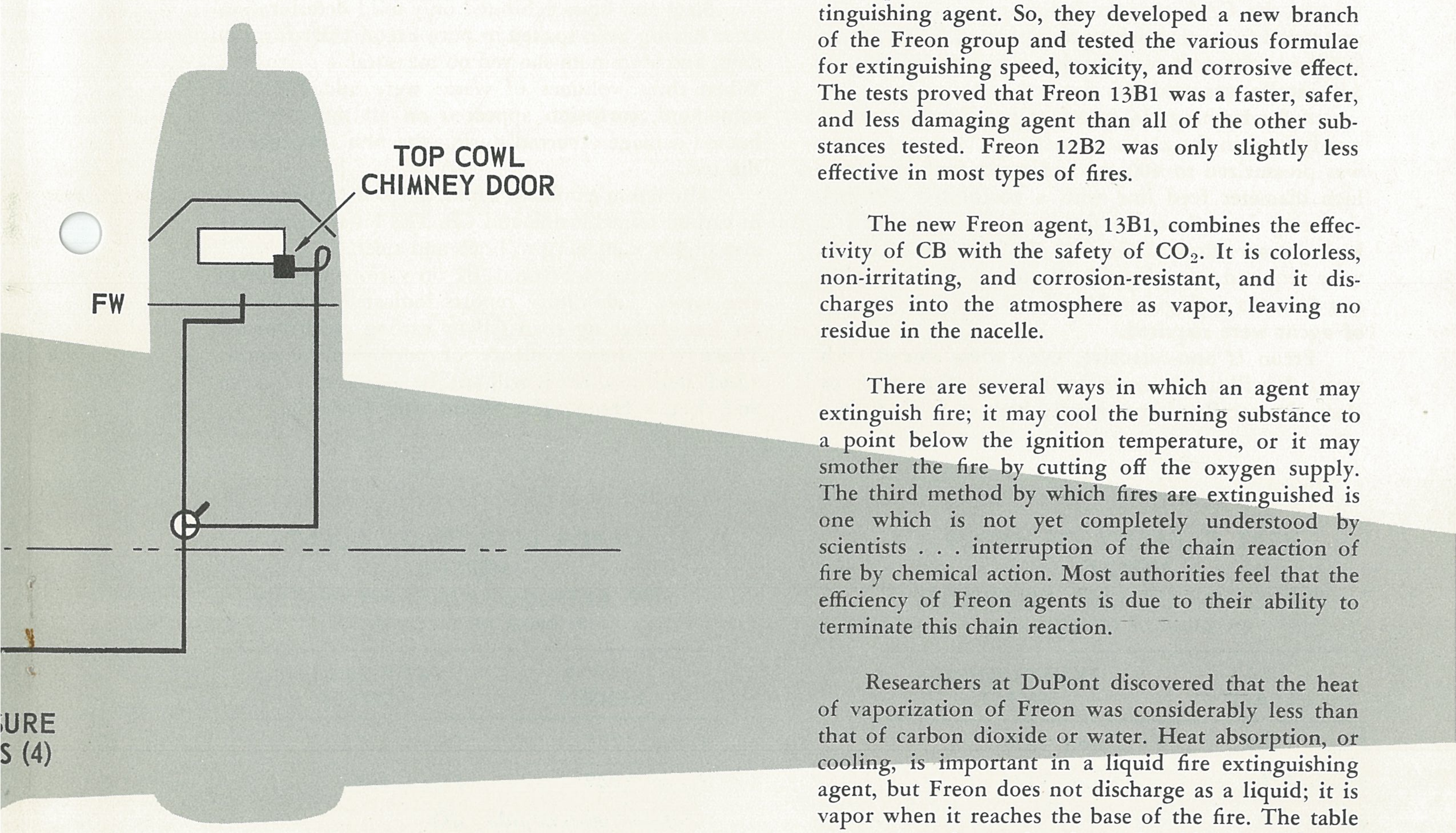
There is also evidence that CB is damaging to metals. Under normal conditions, the agent evaporates before corrosion begins, but where it has puddled or settled in low points, it has a corrosive effect. CB is particularly damaging to aluminum, magnesium, and zinc and, when moisture is present, it may also damage steel, brass, or lead.

hrd

PROPOSED HIGH-RATE-DISC



CHARGE SYSTEM



In order to avoid corrosion, operators with CB systems have found it necessary to clean the nacelle and power plant area and purge the entire fire extinguishing system after use.

For many years, research laboratories at DuPont have been experimenting with a group of chemicals to find one that combined the three basic agent requirements; efficiency, safety, and non-corrosiveness.

The Freon members of the fluorinated hydrocarbon family have long been used by industry as propellants and refrigerants, and DuPont researchers felt that their low toxicity, non-corrosiveness, and inert qualities would also be valuable in a fire extinguishing agent. So, they developed a new branch of the Freon group and tested the various formulae for extinguishing speed, toxicity, and corrosive effect. The tests proved that Freon 13B1 was a faster, safer, and less damaging agent than all of the other substances tested. Freon 12B2 was only slightly less effective in most types of fires.

The new Freon agent, 13B1, combines the effectivity of CB with the safety of CO_2. It is colorless, non-irritating, and corrosion-resistant, and it discharges into the atmosphere as vapor, leaving no residue in the nacelle.

There are several ways in which an agent may extinguish fire; it may cool the burning substance to a point below the ignition temperature, or it may smother the fire by cutting off the oxygen supply. The third method by which fires are extinguished is one which is not yet completely understood by scientists . . . interruption of the chain reaction of fire by chemical action. Most authorities feel that the efficiency of Freon agents is due to their ability to terminate this chain reaction.

Researchers at DuPont discovered that the heat of vaporization of Freon was considerably less than that of carbon dioxide or water. Heat absorption, or cooling, is important in a liquid fire extinguishing agent, but Freon does not discharge as a liquid; it is vapor when it reaches the base of the fire. The table on page 8 shows that heat absorbing qualities of vapors bear no apparent relation to their extinguishing ability.

Smothering action is a major extinguishing factor with the foam type agents and carbon tetrachloride . . . a dense cloud of matter separates the fire from oxygen, smothering the flame like a blanket.

Some of the Freon agents have high vapor densities, but the table below indicates that there is little relationship between density and extinguishing ability. The most dense vapors are not necessarily the most effective ones.

It is obvious from the tables, therefore, that the efficiency of Freon 13B1 and 12B2 must be largely due to chemical rather than physical action.

Other qualities which add to the effectivity of the compounds are their high molecular weight and low viscosity.

A heavy vapor is desirable in a fire extinguishing agent because, to work properly, the vapor must settle at the base of the fire. DuPont chemists added bromine to Freon compounds to give them this needed weight.

Low viscosity is also valuable because it improves flow, pumping, and vaporizing characteristics. Freon's low viscosity gives it an added advantage in a high-pressure discharge system.

At the CAA tests in Indianapolis, Freon 13B1 was tested for extinguishing ability in an HRD system similar to the unit recently developed at Convair. A 340 nacelle was used as a test bed.

A fire burning 2¼ quarts of gasoline per minute was ignited in the accessory section. The agent bottle was pressurized to 400 psi and a one-foot long, ¾-inch diameter feed line with a perforated distribution ring was placed in the compartment. Under a high pressure flow of air, only 0.42 pounds of Freon were required to extinguish the flame. A comparable test fire was extinguished with CB and 1.17 pounds of agent were required.

Freon is non-corrosive, even when mixed with water. It will not be necessary to purge the system or clean the nacelle after it is used because it discharges into the atmosphere as a vapor and leaves no residue. The new agent is also harmless to gaskets and interior plastics. Samples of various synthetic materials were soaked in Freon solutions for several weeks without apparent ill effects.

When the agent was tested on Butyl and other natural and synthetic elastomers at the DuPont laboratories, it caused little, or no increase in the length of most of the substances tested, while CB caused elongations ranging up to 50 per cent.

To test the relative corrosiveness of the various agents on metals, DuPont researchers placed steel, brass, and aluminum strips in pure solutions of CB and Freon 13B1. The metals were soaked in a 120°C solution for 260 days. Concurrently, the same materials were soaked in agent to which water had been added. The extent of decomposition was measured by determining the penetration of the metal at the end of the test and by observing the deterioration of the liquid during the test.

Steel and brass exhibited only mild deterioration after having been soaked in pure Freon 13B1 for 260 days, and aluminum showed no measurable corrosion. When three volumes of water were added to the compound, corrosion appeared on all three metals, but no damage occurred during the first 100 days of the test.

Aluminum exhibited rapid, marked deterioration in carbon tetrachloride and CB. The latter agent was also highly damaging to brass and steel.

The effect of Freon 12B2 on various metals was also tested. Laboratory reports indicated that it was far less damaging than CB or carbon tetrachloride. There was some evidence of corrosion, however, which indicates that it will still be necessary to purge and clean a Freon 12B2 system after discharge.

HEAT CAPACITY OF VAPOR VERSUS FIRE EXTINGUISHING PROPERTIES
(IN ORDER OF EFFECTIVENESS)

HEAT CAPACITY	EXTINGUISHING EFFECT
Freon 12B2	Freon 13B1
Freon 12B1	Freon 12B1
Freon 13B1	CB
CB	Freon 12B2

VAPOR DENSITY OF AGENT VERSUS FIRE EXTINGUISHING PROPERTIES
(IN ORDER OF EFFECTIVENESS)

VAPOR DENSITY	EXTINGUISHING EFFECT
Freon 12B1	Freon 12B2
Freon 12B2	Freon 13B1
Carbon Tetrachloride	CO_2
Freon 13B1	Freon 12B1
CO_2	Carbon Tetrachloride

TOXICITY

The possibility that fumes from power plant extinguishing systems may reach the passenger compartment of an aircraft in flight is extremely remote. However, personnel fighting power plant fires on the ground may suffer adverse effects from toxic agent gases unless proper precautions are taken. Simple smoke or gas from fire may also be hazardous, and an approved gas mask of the canister or oxygen type should be worn in the vicinity of fire regardless of the type of agent used.

There have been no conclusive studies of the effects of Freon fumes on human beings; however, extensive U. S. Government tests of the substances on animals indicate that they have little or no toxicity . . . even after prolonged exposure.

Freon fumes become dangerous only when they reach a volume sufficient to replace the oxygen supply in a closed area.

The U. S. Bureau of Mines recently conducted studies on the effect of Freon on dogs and monkeys. Their report follows:

"Exposure for 7 to 8 hours daily to 20 per cent (by volume) Freon produces mild to moderate to marked generalized tremor in dogs and mild to moderate generalized tremor in monkeys. When they attempt to walk, they act very much like persons suffering from alcoholic ataxia. They react to light and stimuli and do not become unconscious. The maximum severity of symptoms is reached in the first 10 to 20 minutes of an exposure. A tolerance is developed with successive exposures as manifested by decrease in severity of the symptoms. Guinea pigs exhibited no significant symptoms.

"No fatalities occurred among the dogs and monkeys. The fatality among the guinea pigs used for symptoms, weight, and fatality observations was two out of a group of 16 exposed to gas during the 12-week test period.

"Autopsies performed on all animals revealed no gross pathology attributable to Freon."

The U. S. Army Chemical Center conducted additional tests using all the best known fire extinguishing agents. Vapors were studied in their undecomposed state; then they were forced through an iron tube which was heated to 800°C. The compounds were exposed to this temperature for one second.

Rats and mice were exposed to various concentrations of vapor and their reactions were noted. The volume of each of the extinguishing agents was increased until the laboratory animals were asphyxiated.

The following table shows that an intense concentration of Freon 13B1 was required to cause death. Only a small percentage of carbon tetrachloride was fatal to the animals. The Underwriter's Laboratory Classifications system for toxicity which appears to the right of the table is based on a scale of one through six. Materials which are lethal in concentrations of ½ to 1 per cent for five-minute exposures are placed in group 1. Gases in group 6 are those which do not appear to produce injury in concentrations up to 20 per cent by volume for exposures of about two hours. Other substances are rated in intermediate groups, depending upon their exposure and toxic effect when compared to groups one and six.

APPROXIMATE LETHAL CONCENTRATIONS
(15-MINUTE EXPOSURE — PARTS PER MILLION)

AGENT	NOT HEATED (PPM)	HEATED TO 800°C (PPM)	*
Freon 13B1	800,000	14,000	6
CO_2	658,000	658,000	5
Freon 12B2	324,000	7,650	5
CB	65,000	4,000	4
Carbon Tet	28,000	300	3

*Underwriter's Classification

Temporary direct contact with Freon is not harmful, as it evaporates almost immediately; however, prolonged contact may cause frostbite or low temperature burns due to the agent's extremely low boiling point (—76°F).

No special handling techniques are necessary when Freon is shipped or stored. Pressurized shipping containers require the same care as do other liquified compressed gas bottles, and they should be stored in a cool, dry place.

SUMMARY

The CAA proved, and Convair tests confirmed, that conversion to a high-rate-discharge system will increase fire-fighting efficiency and, at the same time, effect a considerable saving in weight — Convair test equipment was 35 pounds lighter than the standard distribution system unit, and the actual installation will approximate this weight saving.

The system is flexible . . . any one of three agents may be used; Freon 13B1, Freon 12B2, or CB. Operators may convert to HRD without sacrificing fleet standardization.

Nacelle cleaning and line purging after discharge may be eliminated with Freon 13B1, but standard anti-corrosion procedures must still be followed if Freon 12B2 or CB are used.

Freon agents are safe . . . they require no special handling and they reduce danger to ground personnel to a minimum.

The initial cost of Freon is considerably higher than that of CB, but the saving in weight and the additional safety factor of the new compound more than compensate for its increased initial cost.

CB16 CB17

ENGINE OPERATING LIMITATIONS

The R2800 CB series engines, as used on many Convair-Liners, are rated at different powers in accordance with the grade of fuel used. The following is a recap of the application of such fuels and the pertinent results.

Heretofore, all fuel was described by one octane number such as "87 octane" or "100 octane." However, it does not adequately describe the anti-knock characteristics of a fuel throughout the usable range of mixture strength. A gasoline meeting 100-octane requirements at rich mixture may be capable of an anti-knock rating of only 87 octane if the mixture is lean. Accordingly, it has become prevalent to identify the fuel grade by two numbers: the first signifies the lean mixture anti-knock rating; the second number signifies the rich mixture anti-knock rating. A fuel like that described would be designated as 87/100 . . . 87 being its lean rating and 100 being its rich rating.

Following are the grades of fuel in current use:

73 octane 87 octane	No rich mixture rating
Grade 91/96	Grade 108/135
Grade 100/130	Grade 115/145

The following power charts show the increased BHP that may be derived from the same basic engine, by utilizing the higher grade fuels. This BHP increase is apparent only at the higher powers, i.e., above 1600 BHP. Cruise power settings for all CB series P&W engines are approximately the same, using any of the three available fuels.

PWA O.I. 108
CB-16 ENGINE

*Engine is certificated for 5 minutes at T.O. power; installation is limited to 2 minutes.
Carburetor PR58E5
Oil—S.U.S. Grade 100 or 120 at 210°F
Fuel Grade 100/130

OPERATING CONDITION	ENGINE SETTING					
RATING	IMPELLER RATIO	BHP	MIXTURE CONTROL	CRITICAL ALTITUDE	RPM	MANIFOLD PRESSURE
Takeoff * (5 min) with water	Low	2400	Auto Rich	5000	2800	58.5 (59.5 S. L.)
Takeoff * (5 min) dry	Low	2050	Auto Rich	6700	2700	53.0 (55.0 S. L.)
Alternate dry	Low	1950	Auto Rich	9900	2800	51.0 (53.0 S. L.)
Maximum Continuous Power	Low	1800	Auto Rich	9200	2600	46.5 (48.5 S. L.)
	High	1700	Auto Rich	16200	2600	47.5 (49.0 at 10,000 ft)
Normal Rated Power	Low	1800	Auto Rich	9200	2600	46.5 (48.5 S. L.)
	High	1600	Auto Rich	18700	2600	44.5 (46.0 0 - 10,000 ft)

PWA O.I. 113
CB-17 ENGINE

*Engine is certificated for 5 minutes at T.O. power; installation is limited to 2 minutes.
Carburetor PR58E5
Oil—S.U.S. Grade 100 or 120 at 210°F
Fuel Grade 108/135

OPERATING CONDITION	ENGINE SETTING					
RATING	IMPELLER RATIO	BHP	MIXTURE CONTROL	CRITICAL ALTITUDE	RPM	MANIFOLD PRESSURE
Takeoff * (5 min) with water	Low	2500	Auto Rich	3800	2800	61.5 (62.0 S. L.)
	High	1900	Auto Rich	15700	2600	49.5 (50.5 - 10,000 ft)
Takeoff * (5 min) dry	Low	2200	Auto Rich	5200	2800	59.0 (60.0 S. L.)
Maximum Continuous Rating—Enroute Emergency	Low	1900	Auto Rich	7200	2600	50.0 (51.5 S. L.)
	High	1750	Auto Rich	15000	2600	49.5 (51.5 - 10,000 ft)
Normal Rated Power	Low	1800	Auto Rich	9100	2600	46.5 (49.0 S. L.)
	High	1700	Auto Rich	15900	2600	47.5 (50.0 - 10,000 ft)

The ratings for this engine are based on grade 108/135 fuel. In an emergency when this fuel is not available, the ratings shown may be obtained if grade 115/145 fuel is used; however, grade 115/145 fuel is not recommended for regular use because of higher lead content.

Should it become necessary to make use of grade 100/130 fuel, the engine must be operated as a CB16 engine and the ratings for that engine must be used. (Refer to PWA 0.1. 108). Any mixture of grades 100/130 and 108/135 fuels must be operated to the Double Wasp CB16 ratings.

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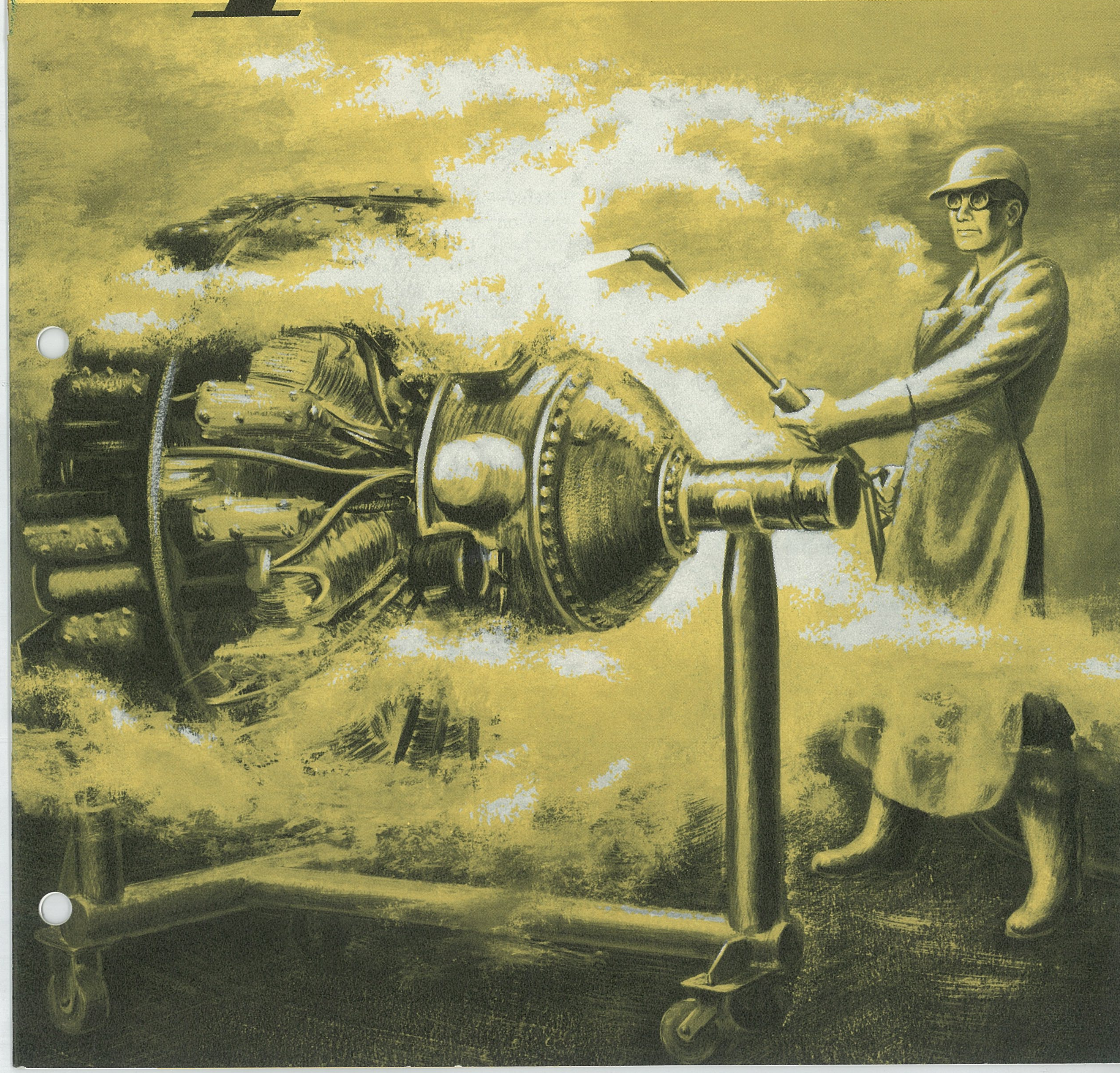


CONVAIR

Traveler

VOL. VIII NO. 3 JULY 1956

FOREWORD

Engineered cleaning methods and close inspection are an unbeatable combination at overhaul time. This month, the Traveler shows how maintenance teamwork — and the proper tools — add speed and safety to overhaul cleaning procedures. After cleaning, scientific inspection methods, dye-penetrant, magnetic particle, and x-ray, seek out hidden defects rapidly and precisely.

ON THE COVER

A jet of steam strips surface grease and grime from an engine, and clears the way for successful disassembly and overhaul.

The artist—Bob Kingett

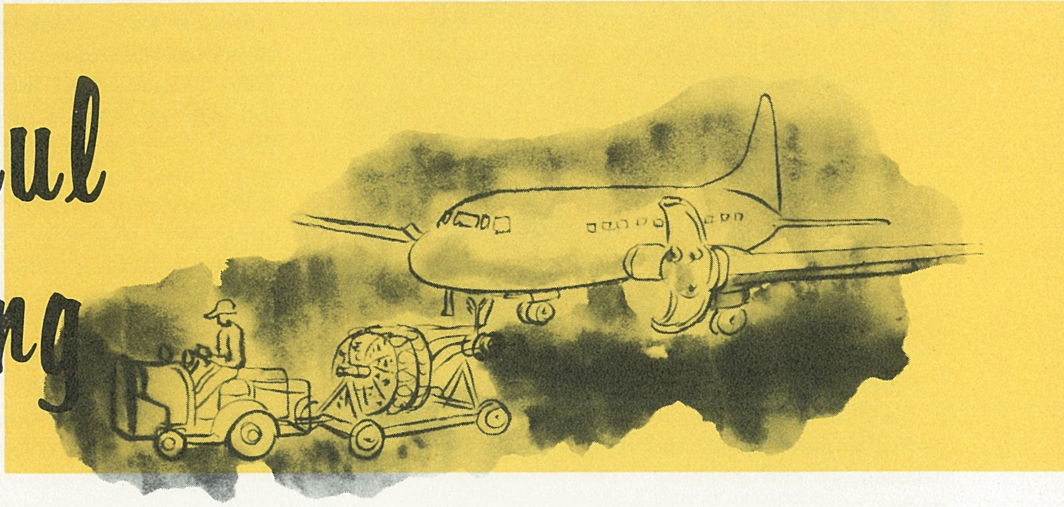
C O N V A I R

A DIVISION OF GENERAL DYNAMICS CORPORATION

(SAN DIEGO)

A digest of Convair-Liner operation and service published monthly by the Service Publications Section of Convair in the interest of Convair-Liner operators. Communications should be addressed to Chief of Service, Convair, San Diego 12, Calif.

Engine Overhaul Cleaning



One of the important phases of aircraft maintenance is cleaning. A clean exterior surface not only reduces fire and accident hazards, but it helps the airline to maintain full payload-carrying capacity. A clean surface reduces operating costs because it takes less power to pull a clean airplane through the air. Dirt and oil, built up on exposed surfaces, create unnecessary drag; hence, high power and low cruise speed. Low cruise speed results in added flight hours . . . added flight hours mean added expense for the airline.

But — the "hidden polish" is just as important. A power plant that is free of carbon deposits, dirt, grit, and sludge operates cooler and smoother — inspection for mechanical failure and/or damaged parts is facilitated. Thus, ground time and operating costs are reduced and performance is boosted. Carbon deposits, dirt and sludge add excess weight to the airplane, and increase the danger of fire . . . clean power plants give passengers a feeling of confidence.

A clean power plant permits precise inspection and fast, efficient disassembly and repair of components, with a minimum of lost flight time. The compounds and methods for this important phase of aircraft maintenance are a result of intensive development by the manufacturers of cleaning compounds who specialize in aircraft maintenance processes and procedures.

Establishment of regular cleaning routines at overhaul, and subsequent inspection, speed procedures and provide more thorough reconditioning.

There are three important functions in engine overhaul cleaning operations: 1) precleaning to remove surface grime and deposits, prior to disassembly; 2) disassembly and cleaning of each part, prior to inspection for repair and reassembly, and cleaning of individual parts which require additional special cleaning treatment; and 3) inspection for flaws and incipient defects.

POWER PLANT REMOVAL

Four rings for attachment of a hoist sling are provided on the engine for removal and installation of the power plant. The power plant unit includes the engine and accessories, the propeller, engine mount, engine shroud, engine diaphragm, and the engine tubing and electrical wiring. In general, the power plant consists of all parts forward of the firewall, except the orange peel cowling and the equipment that is attached to the cowling. All parts, such as the propeller, which will facilitate removal of the engine, should be removed prior to attaching the hoist.

The engine sling consists of a universal type sling beam with a traveling eye to compensate for center-of-gravity variations. The position of the traveling lift eye is controlled by a screw mechanism which is remotely actuated by a chain.

Before removing the power plant, it is advisable to use a friction-type support at the tail post fitting. This support is required only for longitudinal stability, and should not support any of the weight of the airplane. If engines are to be removed while the airplane is on jacks, procedures should be carefully planned, considering the location of center of gravity, both before and after engines are removed.

Precleaning

Proper precleaning of the airplane engine, prior to the disassembly process, is the groundwork for successful engine repair, and it also speeds subsequent disassembly and cleaning. This important step removes initial surface greases, oils, and grime, permitting the mechanic to proceed immediately to the disassembly job, thus substantially reducing time, labor and costs.

Successful precleaning may be accomplished with either an emulsifying agent, such as Turco Airmulso or by steam-cleaning units in conjunction with steam-cleaning compounds. As soon as the engine has been removed from the airplane, it should be thoroughly surface-cleaned by one of these processes. In the use of either method, such accessories as magnetos, generators, switches, distributors, transmitters, etc., should be protected from the entry of cleaning compounds.

Several mild, efficient steam-cleaning compounds have been developed for use in the aircraft industry. These substances are safe to use on all aircraft metals and will not attack or corrode aluminum surfaces. When they are mixed with water to recommended proportions, and are dispensed through a good commercial steam-cleaning unit, they cut grease, oil, sludge, and engine grime. Following application of the steam-cleaning compounds, the surfaces are rinsed with clear, clean water, leaving a clean, dirt-free working surface.

Emulsifying cleaners, such as Turco Airmulso, mixed 1 to 7 with kerosene, present a safe and effective method for cleaning engines. Their use provides complete cleanliness with a minimum of cleaning time, and requires no costly equipment for application. Application of the emulsifying agent is speeded with a spray unit, which is charged to approximately 50 pounds from a compressor air line. The spray penetrates hard-to-get-at spots, and frees deposits around bolts and spark plugs for easy removal. Some mechanical action such as brushing may be required if deposits are particularly heavy. After a soaking period of five minutes, the grease and grime are emulsified (softened) and ready for easy removal with clean water and air pressure, or with a solvent spray and air.

Disassembly and Cleaning

As engines are disassembled, it is generally advisable to assign an identifying number to each part as it is removed. Common shop practice specifies the use of aluminum tabs fastened to the part with aluminum wire. Copper or brass wires should not be used because the copper hydroxides (formed as the wire oxidizes in the air) are soluble in some cleaning solutions, and tend to discolor aluminum alloys. Rubber parts, fabric, cork, and plastic accessories, such as gaskets and plugs, should be removed and cleaned in separate operations, because cleaning solutions intended for heavy engine cleaning purposes are liable to damage delicate materials.

Precleaning of parts and accessories is accomplished in a surge washer or by immersion in a tank. Parts to be cleaned are placed in a washer basket under a circulating cleaning solution for five minutes. After oil and light soil are loosened, the parts are returned to the washer or are water-sprayed by hand for a five-minute rinse. They may then be sent forward to a solvent spray booth. A 20-minute immersion of parts in an emulsifier-filled tank is another effective precleaning method. After immersion, dirt and light soil are sprayed from the parts by water and air.

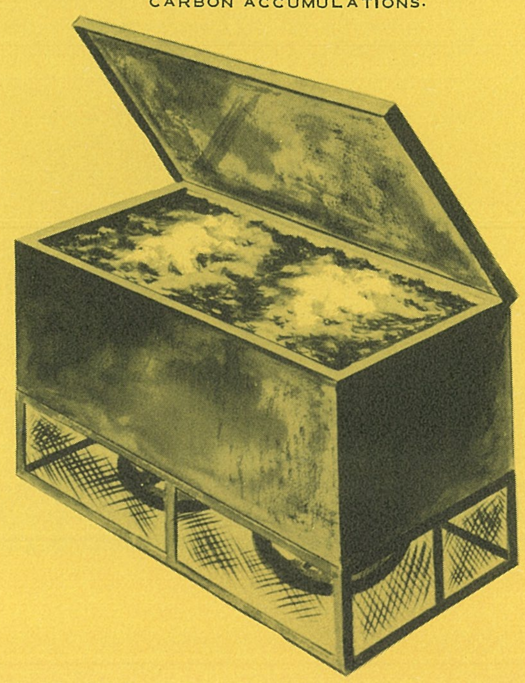
Hard, high-temperature carbons may be loosened and often completely removed by soaking parts for several hours in a carbon-removing solution; however, surge washing with a decarbonizer will do a better job in much less time. Light contamination deposits are frequently removed during the immersion process, while heavier deposits may be finished off by a light, speedy, soft-grit blasting procedure. If the cleaning solvent used does not have a chemical seal, which is important for removing corrosive bromides, the immersion tank should be equipped with a lid to prevent excessive evaporation.

Extremely hard and tenacious deposits of carbon and baked-on fuel residues often remain in narrow grooves of piston and cylinder parts after the normal soaking period. It may be necessary to further treat such parts in order to restore them to their original serviceable functions.

The carboblast process eliminates all necessity for hand cleaning of such parts. The final cleaning of pistons, cylinders, and valves — formerly a repair depot bottleneck — is placed in step with production line overhaul.

Carboblast presents several distinct industrial advantages . . . the plastic particles used in the process are safe and cannot damage metal — masking procedures are eliminated. Carboblast pellets are of various sizes, thus enabling penetration of every machined crevice for complete cleaning. These pellets are long-lived, tough, and durable, giving five or six times longer usage than materials formerly used in this cleaning operation.

SURGE WASHERS EFFECTIVELY COMBINE CHEMICAL AND MECHANICAL ACTION TO REMOVE STUBBORN CARBON ACCUMULATIONS.



Using conventional sandblasting equipment, or a cabinet of special design, carboblast quickly removes the most stubborn carbon accumulations by means of thousands of lignocellulose pellets which buff the material in a blast of air. The pellets penetrate the recesses and knock off carbon residue quickly and safely. There is no possibility of damage, since the pellets cannot abrade, score, or scratch the metal surface.

The carboblast machine is a cabinet with two ports and a glass window at eye level. Placed within the cabinet is a nozzle which is attached to an air line running to the source of air pressure. At the base of the cabinet is a funnel-shaped hopper charged with 50 pounds of lignocellulose pellets. With his hands protected by rubber gauntlets, the operator inserts the work to be cleaned into the cabinet through the ports. The work is held with one hand and the nozzle is directed with the other. Spray is controlled by means of a foot treadle which operates an on-off air valve.

Cleaning Oil Tanks

Cleaning of oil tanks for inspection and repair is an easy task if performed with efficient methods and compounds.

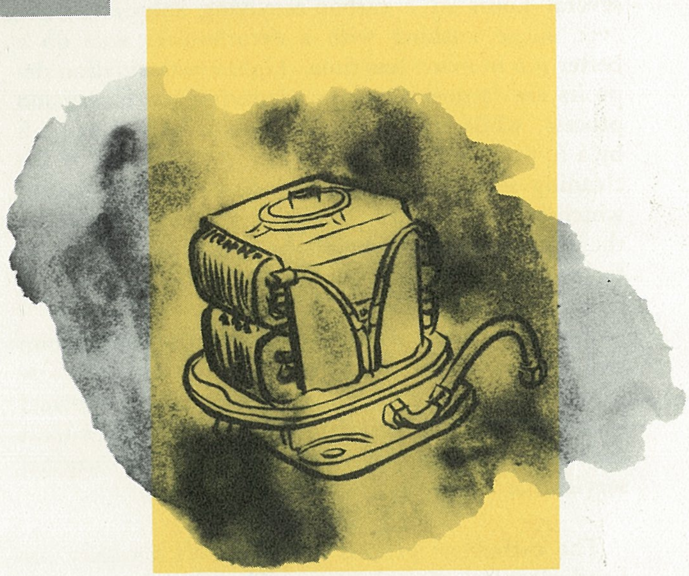
Industrial cleaning chemical manufacturers recommend the following procedure to remove silt and deposits from tanks.

Drain and purge with air blowers; then remove from the airplane and mount in a slusher-type cleaning machine. Fill each tank one-third full with a water-rinsable decarbonizer; then close openings. Rotate tanks slowly for 30 to 45 minutes. After rotation, drain tanks of solvent, rinse with water and air, and steam-clean with an approved steam-cleaning compound.

When the cleaning process has been completed, the tanks may be pressure-tested for leaks with commercial bubble fluid. The solution should be mixed according to instructions and brushed over the exterior of the tank, then air pressure applied. Leaks will show up as air bubbles.

Bubble fluid produces tenacious, thick-coated bubbles which remain evident for a far longer period of time than those produced with liquid soaps.

Cleaning Electrical Equipment



Electrical equipment, like engines, requires careful cleaning if it is to function efficiently. Carbon dust and other conducting soils may cause flashovers, if they are not removed from the motor, and lubricating oils and grease damage delicate insulating materials.

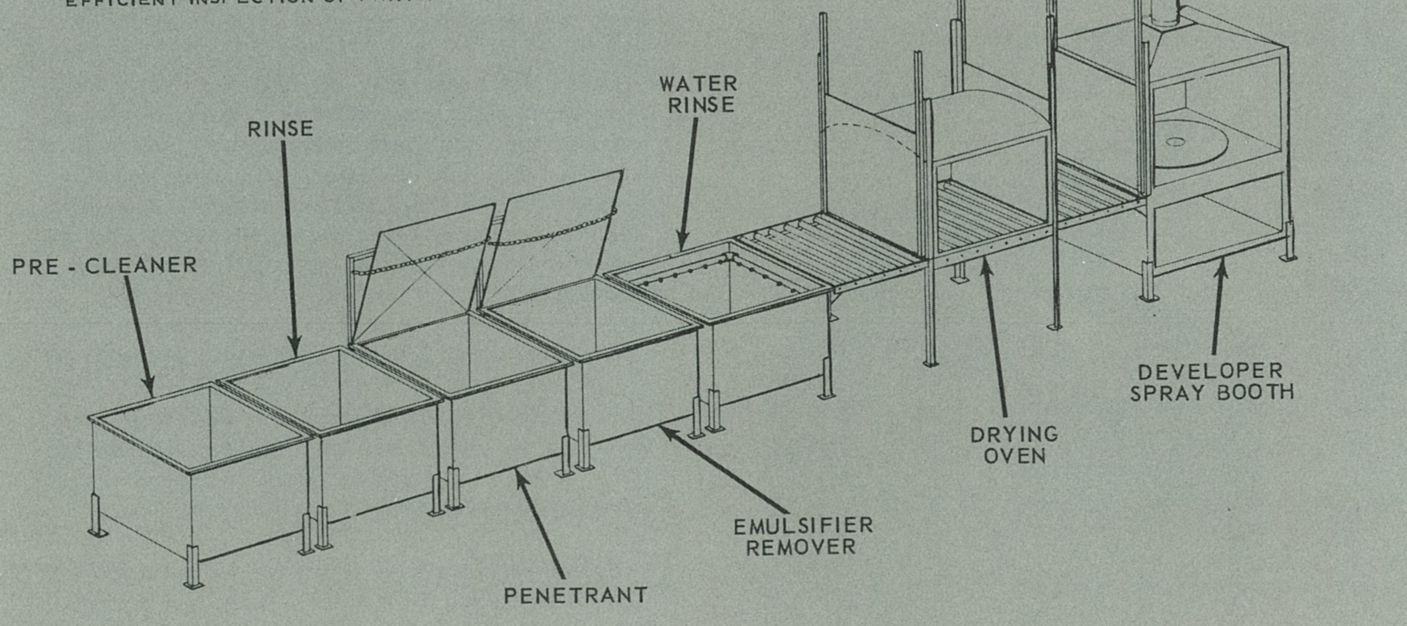
Cleaning solutions which are effective on heavy engine parts are seldom suitable for electrical equipment. They may strip insulating varnish and damage delicate parts.

Carbon tetrachloride, the most commonly used electrical equipment cleaner, has a high flash point and rapid evaporation rate, but it is injurious to personnel; therefore, it is not recommended for use. Personnel must be protected with respirators, goggles, rubber gloves, and aprons when it is used, and adequate ventilation is required to keep concentrations below the danger level of 100 parts per million.

The Turco Company has developed a solvent, Turco-Solv, with the efficiency and high flash point of carbon tetrachloride. It has a rapid evaporation rate and the safety factor of some of the milder cleaners. Turco-Solv is also non-corrosive, non-conductive, and it leaves no residue, thus eliminating many of the problems connected with the cleaning of electrical equipment.

This new "safety solvent" is sprayed on the surface with an air suction gun, pressure pot, or other non-atomizing sprayer. Then, after a dwell time of approximately 15 minutes, grease and grime are loosened and may be easily removed by a second application of Turco-Solv. A jet of compressed air helps to speed evaporation but, whether or not compressed air is used, the solution evaporates completely and no wiping is necessary.

A WELL-PLANNED DYE-PENETRANT INSPECTION AREA WILL PERMIT RAPID, EFFICIENT INSPECTION OF PARTS.



Inspection

Modern, scientific inspection methods, such as penetrant, magnetic particle, and x-ray, simplify procedures by pinpointing weak spots and revealing the nature and extent of defects. Small cracks, imperfections, and holes are not always visible to the naked eye, yet, an engine part with a microscopic crack may cause progressive fatigue failure if it is overlooked during inspection. When engine components are coated with dye-penetrant, the smallest surface flaws stand out in bold relief, and magnetic or x-ray inspections reveal sub-surface defects or porosity.

Dye Penetrant

Dy-Chek, a penetrant made by Turco, is being used by many maintenance depots to speed inspection and to provide a more thorough investigation of critical parts. Defects which are too small to be seen with the naked eye are revealed with photographic clarity when dye-penetrant is applied.

Application of this inspection method is a simple process which requires no special skill or training. After the part has been thoroughly cleaned, red dye penetrant is applied to the metal. The compound stays in contact with the part until surface flaws absorb the fluid by capillary action. Then the penetrant is removed with dye remover and a white developer is sprayed on. As the developer dries, it absorbs the dye from flaws by a blotting action, enlarging visual indications of discontinuities.

When defective parts show up during inspection, they do not delay the inspection process because damaged areas remain visible until the developer is wiped off. Rejected parts may be set aside for evaluation by the inspection department.

Because no expensive equipment is required to convert to dye-penetrant inspection, even the smallest depot or field station may add production line speed and efficiency to their procedures. The only materials required are three liquid compounds: dye penetrant, dye-mark developer, and dye-remover. These may be obtained in kit form from the manufacturer.

The part must be physically and chemically clean before dye-penetrant is applied. Shop soil or light oil may be cleaned from the part with dye remover. If heavy concentrations of carbon are evident, the part may be soaked in heavy duty removers prior to application since some cleaning materials leave a residue which must be removed before inspection.

Different application methods may be used in particular cases. A large number of small parts may be inspected economically by dipping them in the dye, but if it is suspected that penetrations exist through the entire thickness of the part, the dip method should not be used. Instead, the dye may be applied to alternate sides of the part. If large components are to be inspected, dye may be applied with brush or spray. This method may also be more economical than the dip method if only a few small parts are to be checked, or if only a small area of a part is subject to stress or wear.

If a booth to control overspray is available, spraying is recommended because it will assure speedy application of an even coating of penetrant with minimum consumption of material. The developer may be obtained in aerosol containers, if regular spraying equipment is not available.

If dipping is employed, parts should be completely wetted with penetrant, and excess solution should be allowed to drain back into the tank.

Wherever possible, temperature of parts should be at least 70°F, but not over 150°F. Normal dwell time is three to fifteen minutes; however, if a part is extremely cold or, following a grinding operation where grinding cracks are suspected, dwell time should be increased.

Excess surface penetrant may be removed by wiping with a rag saturated with dye-remover. With rough or irregular surfaces, where penetrant removal is more difficult, dye-remover may be applied by spray, brush or quick-dip so as to emulsify the penetrant. Water may then be used freely to remove all traces of excess penetrant, without the danger of removing any of the substance from the defects. After penetrant is removed, the part must be dried thoroughly before developer is applied.

The recommended method of application of the developer is by spraying, since this fast-drying method provides a thin, even coating precluding laps and runs, and insuring clear-cut flaw indications. Spraying provides almost instantaneous sharp flaw indications as rapidly as parts can be handled. A paint spray gun with a vaporizing tip, operating at an air pressure of 25 to 30 pounds, is recommended.

Speed and richness of bleed-back indicate the type and depth of defects. Cracks or openings show up as solid red lines; pits and porous sections appear as scattered red dots; and a partially welded lap shows up as a broken red line.

Removal of the dye-penetrant and developer after inspection is accomplished with a water pressure rinse.

Magnetic Particles Inspection

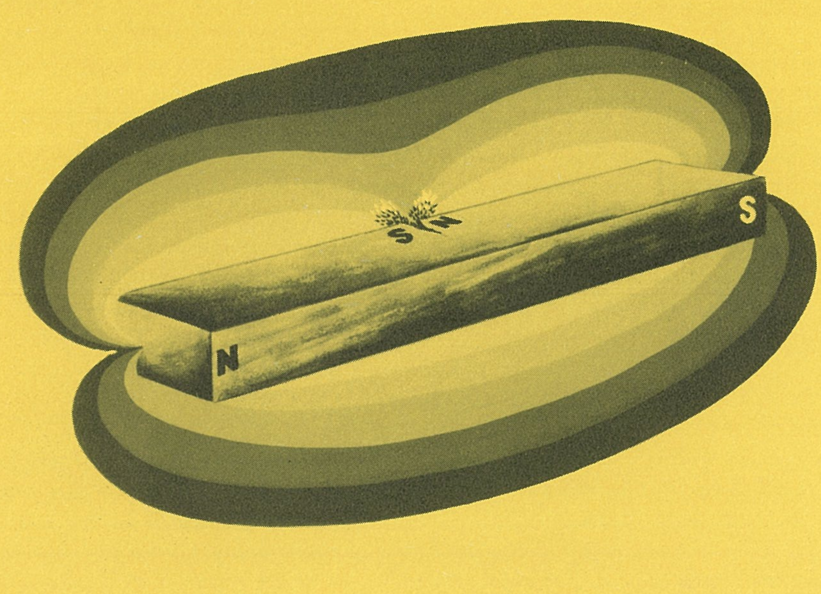
Magnetic particle inspection is one method used at Convair to detect sub-surface flaws in ferromagnetic parts. It operates on the principle that air spaces and discontinuities in iron and steel cause interruptions in the magnetic field which become visible when a magnetic indicating substance (indicator) is applied to the outer surface of the part.

Standard equipment for magnetic particle inspection includes a battery-operated magnetizing table which has one stationary and one movable head, and a narrow, or long coil, demagnetizer.

Prior to inspection, the part is thoroughly cleaned of grease, oil, and dirt, careful cleaning being extremely important because magnetic indicating substances may cling to foreign materials and produce an incorrect reading.

All small openings and oil holes are plugged to prevent accumulation of the indicator, and nonmetallic surfaces are masked.

WHEN A PART IS DAMAGED, NEW NORTH-SOUTH POLES ARE FORMED AT THE EDGES OF THE DISCONTINUITY. THESE INTERRUPTIONS IN THE MAGNETIC FIELD BECOME VISIBLE DURING MAGNETIC INSPECTION.



The part is then coated with indicator and placed in a North-South position between the two heads; an electric current flows through the part, magnetizing it in the desired direction. The pattern of magnetic force becomes clearly visible on the surface of the metal, and imperfections show up as broken spots in the pattern.

The direction of magnetism is an important factor, because the magnetic force is more clearly visible when it strikes a discontinuity at a 90-degree angle. As the angle between force and flaw becomes smaller, interruptions in the pattern become less distinct and, if the flaw is parallel to the force, it is completely invisible. For this reason, parts are magnetized in two directions—longitudinal and circular. This procedure assures that every sub-surface imperfection will become visible.

Indicating Procedures

The indicator may be applied in dry powder form, or it may be suspended in a light oil, such as kerosene, and applied with a brush or hose. The liquid method is more often used in aircraft inspection because it assures an even coating of the part.

The wet procedure has several advantages over the dry procedure for the inspection of aircraft parts. It is particularly adaptable to the inspection of large numbers of parts on a production line basis because of its speed and convenience. Hosing or immersing parts in the suspension will produce a more uniform dispersal of the magnetic particles in less time than with dusting powder.

The wet procedure provides a better control and standardization of the concentration of magnetic particles through control of the concentration of the suspension. Dilution of the suspension fluid disperses the particles to the desired concentration.

Wet indicator is usually supplied in paste form. The paste is gradually mixed with the suspending liquid in a separate container. The mixture is stirred with a flat paddle to a uniform slurry; then it is poured into the tank.

The two basic requirements for a wet process indicator are, 1) high magnetic permeability to insure that a minimum of magnetic energy will attract the indicator to imperfections, and 2) low retentivity to prevent the indicator particles from becoming magnetized.

The suspending liquid should be non-corrosive, non-toxic and, since heat is generated by the electrical current, it should have a flash point of over 135°F.

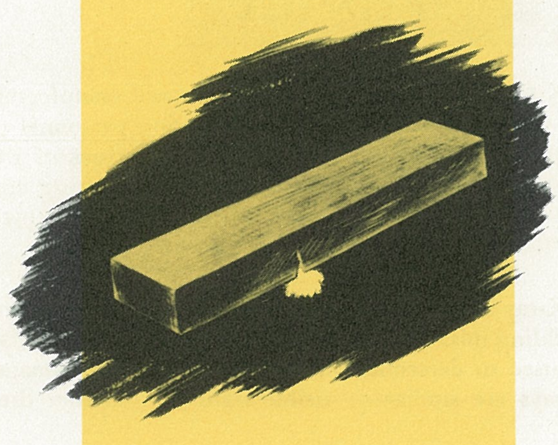
The dry procedure is particularly effective in indicating sub-surface discontinuities, and it is often used in inspecting welds, heavy forgings, or castings which are too large for the wet type inspection units. But most ferrometallic parts on aircraft fit the magnetic inspection equipment.

In the dry procedure, a fine magnetic powder is dusted uniformly over the surface of the part. The powder accumulates at flaws, as in the wet procedure.

When dry powder is applied, it is important to produce a uniform coating. If the coating piles up, or if insufficient particles are available at locations where flaws exist, the flaws may not become visible. An even coating is usually obtained by dusting the powder from a cloth bag or by spraying it from an atomizer. Special spray guns are used on large surfaces.

The dry method is particularly sensitive to foreign matter on the surface. Surfaces must be dry and free from greasy or sticky substances, since they may cause local adhesion of the powder and result in the formation of incorrect indications.

Choice of color for the indicating agent depends on the color of the parts to be inspected. A good contrast is necessary to pick up small imperfections in the parts. Black, red, and gray indicators are available for dry method applications, and black, red, and fluorescent indicators may be used in the wet method. Fluorescence is particularly valuable when parts have poorly visible areas, such as corners, roots of threads, and holes.



When chrome molybedenum steel parts are inspected by the magnetic particle method, a difference in carbon content between the part and mild steel welds may cause false indications of sub-surface flaws. When interpreting flaws on engine mountings and other 4130 steel parts, these differences should be considered.

Demagnetization

Permanent magnetism remaining after inspection must be removed by a demagnetizing operation before parts are returned to service. Power plant parts must be demagnetized to prevent the attraction of filings, grindings, or chips resulting from operational wear. An accumulation of particles on a magnetized part may cause scoring of bearings or other wearing parts. Components in other parts of the aircraft must be demagnetized so that they will not affect flight instruments.

Demagnetization may be accomplished in a number of ways. Possibly the most convenient procedure for aircraft parts involves subjecting the part to a magnetizing force that is continually reversing in direction (A-C power source) and, at the same time, gradually decreasing in strength. As the decreasing magnetizing force is applied first in one direction and then the other, the magnetization of the part also decreases.

The method usually employed for developing this reversing and gradually decreasing force is to energize an air coil with alternating current. As the part is moved away from the alternating field of the magnetic coil, the magnetism in the part gradually decreases.

X-Ray Inspection

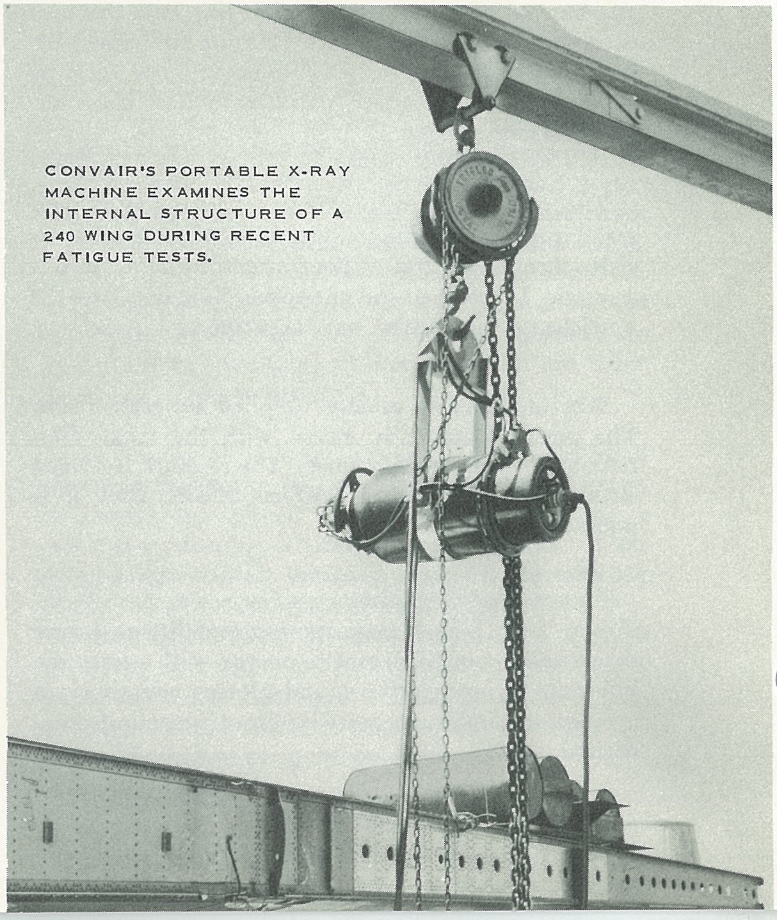
X-ray, a valuable tool for airlines and manufacturers enables maintenance and production personnel to inspect a part without disassembling portions of the structure. It is being widely used for inspecting and recording the internal structure of castings, welded assemblies, and ducting during engine overhaul.

X-ray inspection picks up such faults as loose rivets, buckling misalignment, and corrosion, and it may also be used to determine the extent of accident damage. X-rays are similar to visible light rays in that they travel in straight lines and act on photographic film emulsions. Because of their extremely short wave length, x-rays penetrate objects through which visible light cannot pass.

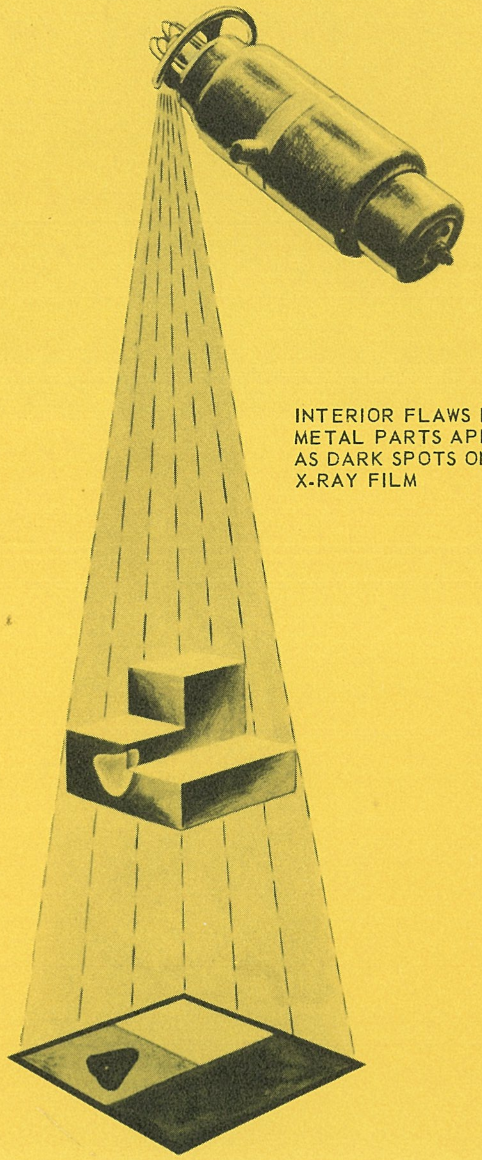
The ability to penetrate objects which are opaque to visible light would be useless if all objects, despite differences in density and thickness, absorbed the same amount of x-ray. But, this is not the case. Absorption of x-ray is proportional to the thickness, density, and type of material. Thin sections absorb smaller quantities than do thick sections; dense metals, such as iron, absorb greater quantities of x-ray than do metals of low density, such as aluminum; therefore, if a metal part containing blow holes, slag, or other defects is placed between the x-ray source and a photographic plate, the flaws appear as dark areas on the film.

Depending on equipment and exposure conditions, an x-ray unit is usually sensitive to a defect greater than two per cent of the thickness of the part. This means that on thin material, such as the skin, a slight corrosion can be detected. Thicker parts, such as sections of structure, will not usually reveal a defect unless it is at least two per cent of the total thickness of the section being x-rayed.

Because of this limited range, x-ray is seldom used for detection of small internal flaws which are less than two percent of the thickness of heavy forgings, and it will not penetrate aviation fuel because of the



CONVAIR'S PORTABLE X-RAY MACHINE EXAMINES THE INTERNAL STRUCTURE OF A 240 WING DURING RECENT FATIGUE TESTS.



INTERIOR FLAWS IN METAL PARTS APPEAR AS DARK SPOTS ON X-RAY FILM

lead content. Another limiting factor in x-ray inspection is the visual range of the human eye. Defects which appear on film are often too small to be seen.

Trained operators soon learn to interpret various signs on x-ray negatives . . . a dark-colored line may be a crack in a casting, dark areas may be caused by uneven shrinkage within the metal, pits appear as mottled areas, and surface roughness appears as irregular light areas. Practically any properly made radiograph of a commercial casting will reveal discontinuities within the structure of the metal, but trained operators soon learn to judge the relative importance of defects.

To assist inspectors in the measurement of defects in small parts, a penetrameter, a small rectangular piece of metal which has the same material thickness as the part being tested, is placed on the part. Three holes in the penetrameter represent various percentages of the thickness of the material. After the negatives are developed, the operator may use these holes, which appear on the film as black dots, to estimate the percentage of defects in the part.

X-ray inspection is usually not a full-time occupation, so most of the airlines who use the process select one or two members of their regular inspection staff for training in radiography and film processing. Trained aircraft inspectors are preferred for this work because an intimate knowledge of aircraft structure is essential for the correct positioning of the set, and for accurate interpretation of negatives.

Personnel operating x-ray equipment are subject to various state and national safety laws. Among the hazards inherent in the operation of the equipment are electrical shocks and radiation damage. Excessive and repeated exposure to x-ray may cause an increase in the number of white corpuscles in the blood stream, and a corresponding decrease in the number of red corpuscles, resulting in anemia. Continued excessive exposure may also result in painful surface burns which are similar to burns from caustic, but which are far more difficult to heal.

The belief that even a brief exposure to x-ray causes sterility is a common misconception and, like many persistent rumors of this nature, has no basis in fact. Excessive, prolonged exposure is necessary to cause this condition.

The possibility of radiation burns may be minimized by the use of lead-lined, or heavy concrete rooms. In addition, detecting devices may be used to measure exposure and leakage around the x-ray room. Small film capsules may be worn by x-ray operators and developed at regular intervals to determine the extent of radiation; heavy gloves and aprons may be worn as an additional precaution.

Electric shock dangers are negligible, and they are further minimized by the use of shockproof cables.

Industrial x-ray equipment ranges from elaborate stationary units in lead-lined rooms to small portable sets which may be used at field maintenance depots. Requirements for x-ray equipment will depend, to a large extent, on the size and nature of an airline operation; however, 16 of the 17 domestic and overseas airlines using x-ray inspection have portable units with kilovoltages of 60 to 75. Portable equipment is generally preferred, because it reduces handling costs and cuts the time spent on positioning.

CONVAIR

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ATA CONFERENCE

SPECIAL ISSUE

CONVAIR
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Chief of Service
J. J. Alkazin

Editor
G. S. Hunter

ON THE COVER

ON THE COVER

The theme of the 1956 ATA Conference is skillfully adapted to this month's cover by artist Bob Sherman.

CONVAIR
A DIVISION OF GENERAL DYNAMICS CORPORATION
(SAN DIEGO)

A digest of Convair-Liner operation and service published monthly by the Service Publications Section of Convair in the interest of Convair-Liner operators. Communications should be addressed to Chief of Service, Convair, San Diego 12, Calif.

INTRODUCTION

In this expanded issue of the Traveler, are published many of the speeches presented at the recent ATA Conference, which was held in San Diego on May 14 and 15.

The Traveler is happy to present these informative and timely items as a service to the industry. Although all of the articles contain much useful and valuable information, we must say for the record that their publication herein does not necessarily constitute official approval or indorsement by Convair.

Many thanks to all of the contributors who made this issue possible.

ATA

CONVAIR 340 ELECTRICAL SYSTEM

R. Garris on ....BENDIX — RED BANK DIVISION

In the development of aircraft to present day high performance and utility, the requirement for more and more electric power has become a major consideration. Since more electric power is in demand, higher capacity generators have been designed to meet the added aircraft load requirements. Consequently, it becomes necessary, as a safety measure, to provide adequate fault protection equipment for the aircraft electrical system in case of some unforeseen combination of events.

The electrical power and fault protection system, normally installed on Convair 340's, consists of the following units:

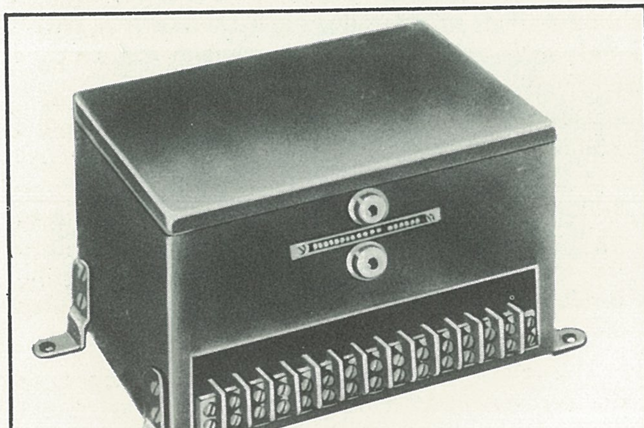
1. Generator—type 30E02
2. Generator Multiple Circuit Breaker—type 35E04
3. Line Contactor—1563 or Hartman A751D
4. Fault Detecting Panel—type 35E05
5. Generator Control Panel—type 1539.

The fault protection system is designed to detect faults and to deenergize and isolate a generator and its circuits from the aircraft operating bus in case of overvoltage, failure of a reverse current relay, or occurrence of a fault to ground of a generator, or of its associated feeders or control circuits.

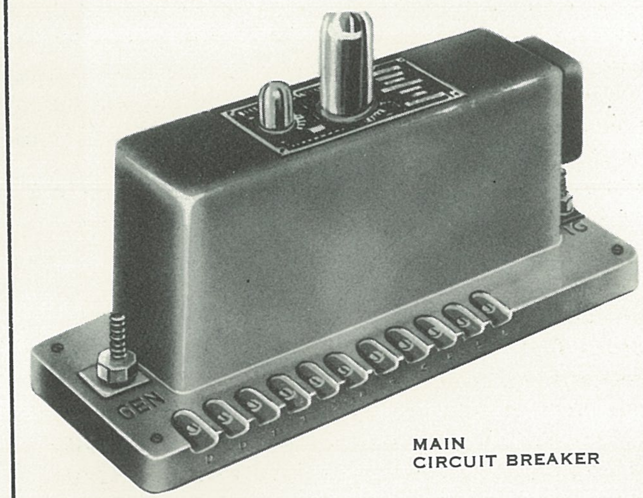
OVERVOLTAGE. The generator circuit breaker is caused to trip before an overvoltage condition in the generating system can persist for an unsafe period of time.

The functions of detecting overvoltage and selection of the faulty generator are both performed by one relay located in the fault detecting panel. Detection and selection is certain and positive for any speed or load condition, and occurs whether the faulty generator is off the bus, is the only generator on the bus, or is one of several paralleled generators. The overvoltage relay operates whenever generator voltage exceeds approximately 30 volts, if two or more generators, including the faulty one, are on the bus. The trip value for slowly-increasing overvoltage is independent of generator load or speed. If, however, the faulty generator is not paralleled with any other generator, tripping of its associated overvoltage relay occurs at 33 volts. The time delay of the overvoltage relay ranges from 1½ seconds for a voltage just exceeding the trip value, down to 10 milliseconds for overvoltage exceeding approximately 80 volts.

Under the severe conditions of a generator field-to-armature positive start, at light load and high generator rpm at takeoff, detection and clearing will occur before a sensitive type lamp filament will fail.



VOLTAGE REGULATOR AND FAULT DETECTOR PANEL



MAIN CIRCUIT BREAKER

However, no false trips will occur, owing to 1) opening and closing of generator shunt fields; 2) application and removal of full system loads, or overloads; or 3) the occurrence of overvoltage in another generator.

FAULTS TO GROUND. The system, as installed on the Convair 340, is arranged to detect and clear heavy faults to ground. Heavy faults are considered to be those exceeding 300 amperes. Use of the fault current itself to trip the breaker provides maximum speed of combined detecting and clearing of a heavy fault, since only the time delay of the breaker itself is involved.

REVERSE CURRENT RELAY BACKUP PROTECTION. If for any reason, the feeder contactor should fail to open when the corresponding generator is inoperative, a reverse current through the breaker, exceeding 300 amperes, will cause the breaker to trip. The tripping time is an inverse function, and ranges from approximately three seconds at 300 amperes, to approximately eight milliseconds for large reverse currents. Proper inverse time delay is necessary to allow the reverse current relay to operate for all normal conditions of reverse currents.

FAULT CLEARING. When a fault causes the generator circuit breaker to trip, it opens the generator to bus feeder. It also opens the generator field circuit on each side of the voltage regulator pile, and opens other necessary control circuits, including the regulator equalizer circuit. It also closes a warning light circuit.

Following are reported instances wherein complete d-c power has been lost:

Case 1. *Simultaneous fault in each generator of a two-engine system.* A complete power failure was experienced by one Convair operator. Examination of the equipment indicated one generator had failed, due to a grounded armature. The other system became inoperative after the reverse current relay coil winding, the paralleling fixed 3-ohm resistor, and the connecting wiring had overheated and deteriorated in the 1539-O-A control panel. It was assumed that this failure was caused by a high-resistance connection at the generator "E" terminal which imposed excessive voltage on the failed components.

Case 2. *Complete d-c system failure.* In this case, both main generator circuit breakers tripped during normal flight. Pilot's log did not designate which generator went off the line first, or whether they both went off the line simultaneously. It is fairly obvious that the pilot was not aware that the breakers tripped, and a condition existed where the entire ship's load was put on the battery. When the pilot finally realized the loss of the generators, the battery had dropped to a low potential (below 16 volts), making it impossible to reset the circuit breakers electrically. Since the circuit breakers on this installation are not accessible during flight, they could not be reset mechanically, and a complete loss of d-c power resulted. On examination of electrical equipment taken from this airplane, it was found that oil had gotten into the left-hand generator, causing the armature to ground. Why the right-hand generator circuit breaker tripped was undetermined. Since no faults existed in the right-hand generating system, it is believed that this system could have been brought back on the line if the pilot had noted complete loss of generators on occurrence.

Case 3. *Reported complete d-c system failure.* A check of the pilot's log book indicated that both generators went off the line at the same time while in flight. The breakers (35D04) would not reset electrically. Time intervals were not given in the log; however, in checking the electrical system of the airplane in the hangar, it was found that the nylon cord in the cabin, which is used to mechanically reset the circuit breaker, had broken. In an effort to duplicate system failure, the airplane was run up outside the hangar with generators operating in parallel with 40 per cent of ship's load. Load was shocked, and wing flaps were operated with no failure in 45 minutes running time. Generators paralleled satisfactorily, each carrying 50 per cent of the ship's load.

It is our opinion that if the generators could have been brought back on the line, electrically or mechanically, the system would have functioned properly.

RESULTS OF TESTS TO DUPLICATE SERVICE TROUBLES. Since there were instances of power failure with no apparent reason, tests were run in the laboratory to investigate possibilities of system malfunction. A mockup of the Convair 340 system was made, using serviceable components obtained from one of the operators.

During the tests when a full load was applied in a rapid cycling to the system, the operating problem was duplicated. This action simulated a faulty generator being removed and the whole load being picked up by the remaining system. The fault was traced to the overvoltage relay in the 35E05 fault detecting panel. The overvoltage relay was checked and found outside the limits of our overhaul manual.

The relay was again installed in the system with the cap removed to observe the operation of the plunger. As the load was placed on and off, the plunger moved toward the seating or trip position, but did not return to normal operating position after the action. Instead, it continued to creep to the trip

position. It was concluded that the trouble was caused by the plunger return spring being weak.

The plunger return spring was changed and the system was without failure, verifying the conclusion noted. The minimum operating current of the relay was checked and found to be low (460 MA instead of 500 MA minimum). Thus, we believe that if the 35E05 fault detecting panels are checked according to the requirements of our overhaul manual, no troubles should occur in the system. In particular, a faulty plunger return spring should be evident if the minimum trip currents are lower than prescribed.

To provide a more complete check on the overvoltage relay, which seems to be the source of trouble, we are considering issuing an inverse time-voltage characteristic test. This information will be provided as an addendum to the existing overhaul manual.

COMPONENT IMPROVEMENTS

The following design improvements have been incorporated in components of our manufacture for these aircraft.

30E02 D-C Generator. The armatures are now being tunnel-wound to provide more uniform shaping and spacing of the conductors. This lessens the possibilities of the conductors shorting or grounding. This procedure also eliminates many of the abuses of hand-forming of the coils.

Equipment used to weld the armature conductors to the commutator risers has been modified to provide a continuous flow of cooling water over the commutator, and automatic cooling of the weld during the proper portion of the cycle. This practice lessens the chances of annealing the commutator bars during welding and, in turn, decreases the possibility of acquiring a high bar or cracked weld in service.

The shunt field lead is brazed to the "E" lead, wrapped for approximately two inches back from the braze, and coated with Glyptol to prevent it from unraveling. This will support the shunt lead and lessen the possibility of its breaking due to vibration.

The spun sheet metal blast cover has been replaced with a die cast cover of more rigid and dependable construction. This is covered in Service Bulletin No. R-14 for retrofit, and is effective with the "G" style generators.

A longer brush, available as a spare part, will permit brush life up to 1800 hours on some installations. The recommended long split brush is P/N 1323208. A long solid brush (P/N 1323209) will be supplied upon request.

Fafnir bearings are now used exclusively and are packed 40±10 per cent full with Texaco Hi-Temp grease. The 66 2/3 per cent pack formerly used resulted in commutator contamination due to the excess grease being expelled. It was also found that once the bearing started to purge grease it sometimes would not reseal, permitting all the grease to purge out.

Several operators have practically eliminated bearing failures by spinning the bearings on a mandrel, prior to installation. The bearing is placed in a split bearing retainer and manually held against a tapered mandrel. Those bearings appearing excessively noisy or rough are discarded.

28E04 A-C Generator. The anti-drive-end shaft bearing fit has been tightened to prevent the bearing from spinning, a cause of excessive wear and fretting corrosion. A bearing fit of line-to-line to .0004 inch tight should be maintained between the shaft and the ID of the bearing.

A Service Bulletin is being prepared by Bendix.

The 8-32 head-to-head screws were replaced with 10-32 screws to reduce bolt failures. This change is covered by Service Bulletin No. R-26.

The screw and bearing clamp washer, used to hold the inner race of the anti-drive-end bearing, will be replaced with a one-piece heat-treated screw and washer (P/N 1109743), containing a nylon insert. The heat-treating operation will permit torquing the screw to 100 inch-pounds; the nylon insert will prevent the screw from loosening. It is believed that this change will greatly reduce the failures occurring in the field, due to the old screw backing out. A Service Bulletin is being prepared to cover this change.

Note

For current modification of the 28E04 generator, use Service Bulletin No. R-33 and its references in conjunction with the bulletins being prepared for the recommended bearing fits and the new nylock screw.

IMPROVEMENTS IN VICKERS EQUIPMENT

USED ON CONVAIR 240 AND 340 AIRCRAFT

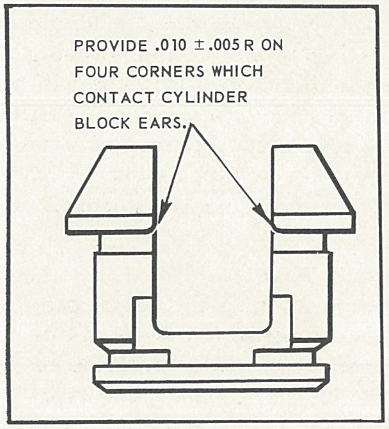
C. H. Merrell .... VICKERS, INC.

Vickers has made a number of improvements during the past year in the hydraulic units used on Convair aircraft. These changes have been covered by service bulletins which all operators should have received. Therefore, we will briefly review only those improvements at this time.

There are two significant changes in the PF17-3911 pumps. When operators began to report a decreased service life due to early wear between the cylinder block ears and the universal link retainer, Vickers started a laboratory program which ultimately disclosed a way to eliminate the problem. It was found that by assembling the retainer in the cylinder block with an interference fit, the problem was solved. Vickers Service Bulletin A-138 was released to cover this change as applied to the standard two-eared cylinder block.

Beyond the interference fit, it was decided that a four-point cylinder block, also with an interference fit at the ears, would provide even greater reliability Hence, a new design model of the pump, the PF-3911-4 series, was made available as an active production and service model. This new model and its improvements was covered by Service Bulletin A-140. Future service requirements will be covered by providing only the necessary parts to give an interference fit at the cylinder block ears, with either a two-point or a four-point block drive.

In addition to these pump changes already released, there are additional improvements which should become effective in the near future. After extensive laboratory and field tests, Vickers has determined that the service life of both the fixed and flexible bearings used in the rotating groups of pumps and motors can be improved by making them from nylon. These bearings are presently made from a bearing bronze. A service bulletin will be issued to cover the various models affected at the time the nylon bearings become available.



DESIGN CHANGES IN CYLINDER BLOCK AND UNIVERSAL LINK RETAINER, SHOWING INTERFERENCE FIT AT CYLINDER BLOCK EARS

The diaphragms used in Vickers 3000-psi 7½-inch accumulators have presented a problem for some time because of shortcomings in the base synthetic rubber originally approved. In addition, the base stock being used had become over-age, with the result that for a long period, Vickers was not able to accept any diaphragms from our usual source that could be guaranteed to give a satisfactory service life. Therefore, it was necessary to develop and qualify a completely new and different compound for use in Vickers spherical aircraft accumulators. That objective has been accomplished so that today Vickers is again supplying fully guaranteed diaphragms and accumulators. A service bulletin will be issued soon to cover this change in material which will become effective in all Vickers accumulators.

For the 7½-inch accumulators, 99008 diaphragm sub-assembly has been superseded by 182844 diaphragm subassembly. Only the latter will now be supplied as a service part and used in production accumulators. The use of nitrogen pre-charge is recommended in lieu of air. The use of nitrogen will increase the life of the diaphragm.

The final improvement in Vickers units, as used in Convair aircraft, applies to the AA-34500-A series unloading valves. Fatigue failures of the body in the area of the internal pressure sensing hole after prolonged service should be eliminated through the use of a better forging. The forging material has been changed along with the forging die. Since the body failures were in the area of the parting line of the forging, a new forging die with the parting at right angles to the sensing hole has now been made, in addition to a strengthening in the failure area. Only the new bodies will be used in future production and service parts. Service Bulletin A-149 covers in detail this change.

Vickers is now expanding its service facilities both in Detroit and El Segundo so that we will be able to provide better and quicker service.

Frank J Lesnewsky .... HAMILTON STANDARD

DUAL FEATHERING LINES

Reports of inability to feather revealed that the feathering line became broken when the engine cylinder to which it was attached lifted from the power case. Recently, at the request of TWA, a dual feathering line configuration was designed and will be made available upon request for all Hamilton Standard feathering propeller installations. Following is a description of the dual feathering line.

In the dual feathering line schematic, the selector and check valve assemblies are shown in their relative positions with reference to the auxiliary pump and governor. Within the selector valve assembly are the spring-loaded selector valve, a pressurizing valve, two bleed check valves for normal and emergency lines, and a pressurizing bleed, which bypasses the emergency line bleed check valve. Two check valve assemblies are used at the governor inlet, one for the normal feathering line and one for the emergency line. Each check valve incorporates a bleed shutoff valve.

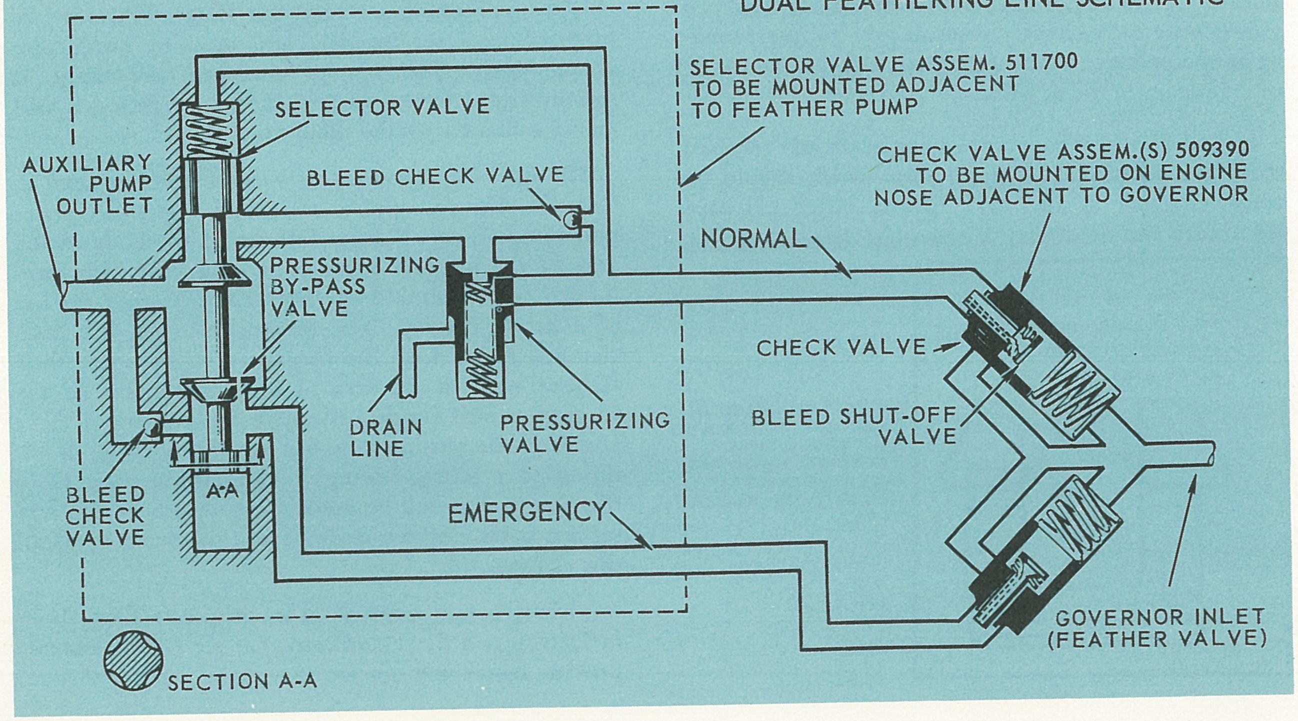
The system operates as follows: With the selector valve spring-loaded in the normal position, energizing the auxiliary pump provides oil to the pressurizing valve which opens and permits high-pressure oil to back up the selector valve and, at the same time, to flow through the check valve to the governor. As long as the normal feathering line is intact, nothing else transpires except for pressurization of the emergency line through the bleed, which bypasses the emergency line bleed check valve.

If a normal line failure occurs at any position downstream from the selector valve assembly, the pressure, which backs up the selector valve and spring, is lost and the valve shifts instantaneously to the emergency position as a result of the force produced by the pressurization of the emergency line through the bypass bleed. At the same time that the normal line check valve closes, the emergency line check valve opens, and feathering proceeds without interruption, and with no further loss of oil.

The anticipated approximate valve pressure settings are as follows:

Selector Valve	70 psi
Pressurizing Valve	800 psi
Check Valve	300 psi
Bleed Shutoff Valve	500 psi differential

DUAL FEATHERING LINE SCHEMATIC



FEATHER LINE FILTER

The flow of engine. oil to the governor passes through the mounting gasket screen, which is designed to check the passage of foreign material of a harmful size; however, auxiliary oil coming directly from the oil tank is normally supplied to the governor without the benefit of screening. Successful service-testing of feather line filters (P/N 513570) on P&W R2800 engine installations indicates that this device offers satisfactory screening of undesirable foreign particles from the governor and is offered for installation on all Hamilton Standard feathering installations.

A sample filter was sent to the CAA Technical Development and Evaluation Center, Indianapolis, in January 1955. The unit was submitted to a fire-resistant test, as outlined in CAA Service Release No. 259. In brief, this test called for the filter to be exposed to a flame of 2000°F for a duration of five minutes.

During the first 4.5 minutes, SAE 20 oil at 150 psi was passed through the filter at a rate of one quart per minute; during the last 30 seconds, the oil pressure was increased to 1650 psi. Acceptability of the filter was based upon its compliance with the test conditions without evidence of failure or leakage sufficient to aggravate the existing fire. The sample unit satisfactorily completed the requirements of the fire-resistant test to meet CAA requirements.

The service test was primarily conducted to determine that the filter could be used for a scheduled engine operating period without servicing; and that it could function without clogging, permitting the passage of unscreened oil through the open bypass valve on the governor.

Details of the 513570 filter are as follows:

Weight	1.75 pounds
Screen Size	14-wafer screens, 60-mesh, 246 microns
Flow and Pressure	20 quarts/minute with 13 psi pressure drop, using SAE 50 oil at 150°F. A bypass relief valve is provided which is set for 35 psi and, after opening, will pass 20 quarts/minute with a total pressure drop of 45 psi.
Proof-Pressure Test	2500 psi

Further details concerning installation and overhaul data will be provided in a Hamilton Standard Service Bulletin.

GOVERNOR PILOT VALVES

Synchronization difficulty and unscheduled engine rpm, resulting from pilot valve sticking, may be caused by foreign material between the pilot valve lands and the drive gear shaft. To preclude pilot valve sticking from this source, it has been determined that preventing its rotation with the drive gear shaft will tend to keep the foreign material from becoming lodged between the two parts. A means for providing a restrained pilot valve is described in Hamilton Standard Service Bulletin No. 350. The propeller manufacturer recommends that this feature be installed in service units at the next overhaul.

GOVERNOR ELECTRIC HEAD

Service experience continues to indicate that the addition of Texaco Regal AA-R&O oil in the electric head cavity adds to the life expectancy of the gear teeth, shafts, and bearings in the governor. A Hamilton Standard Service Bulletin will soon be issued to cover this subject.

PROPELLER EXTERNAL LEAKAGE

While propeller external leakage has not reached serious proportions, the nuisance it creates is fully realized and Hamilton Standard have been actively engaged in providing a solution for it. Considerable relief from this difficulty has been achieved through the use of reduced cross-section restrained blade packings, either with or without Teflon foil on the blade shanks. Laboratory experiments with various changes in barrel sealing are being conducted, and one is on service test at United Airlines.

Acceptance of a satisfactorily tested arrangement will be presented for general application in a Hamilton Standard Service Bulletin.

TAKEOFF RPM OFF-SPEED

Oil in the governor flyweight cavity can contribute greatly to takeoff rpm off-speed conditions. To reduce this possibility, Hamilton Standard have recommended the incorporation of a second internal drain passage in the governor. Hamilton Standard Service Bulletin No. 345 covers this modification and lists the model identifications associated with reworked assemblies as well as the current production models which have the dual drain passages.

Another means of reducing takeoff rpm off-speed problems is provided through the use of four flyweight type governors which are currently in production. This new assembly is designed to improve sensitivity for off-speed corrections. By utilizing a stiffer speeder spring to compensate for the heavier flyweight loads, the positioning forces acting on the pilot valve are such that, for small off-speeds, increased port openings are obtained, thereby increasing the rate of oil flow, which in turn increases the rate of propeller pitch change for these limited off-speeds. This arrangement results in improved governing action.

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PHILOSOPHY OF GENERAL ELECTRIC SERVICE TO THE AIRLINE CUSTOMER

...... GENERAL ELECTRIC CO.

Knowing how and when to use the General Electric facilities already available is an essential part of servicing commercial aircraft. For this reason I would like to cover in the time allowed, what the General Electric organization directly involved is like, and how our servicing is accomplished.

The General Electric Company Distribution group has an Apparatus Sales Division. Under this division are two departments servicing the commercial airline customer. One department is our Aviation & Defense Industry Sales; the other is an Installation & Service Engineering Department. The Installation & Service Department, similar to the Sales Department, is divided into six districts. This particular (West Coast) area is called the Western District and covers California, Arizona, Utah, and Nevada, with district headquarters at Los Angeles. These district organizations are national or domestic in scope and have a direct responsibility for domestic aviation sales and service. Geographically, the Apparatus Sales Division is broken down into six districts, each being responsible to a District Manager of Sales or Service. These districts and their headquarters are: Northeast District with headquarters in New York; Southeast in Washington; Southwest in Dallas; Central in Dayton; Pacific Northwest in Seattle; and Pacific Southwest in Los Angeles. Each district office is a complete organization furnishing sales and engineering services, plus order service functions and service shop facilities. This type of organization is flexible and can meet the local requirements.

The commercial aviation systems engineering organization has Al Brandt as a field service engineer, whom I'm sure you all know or have met during the satisfactory solution to your service problems. Al Brandt services airline customers on a national basis in conjunction with district offices.

In the case of overseas airline operators, there are two types of organization covering sales and service. One type, presently used by the Aircraft Gas Turbine Division, has direct factory representation at overseas engine installations. The other type organization, presently used by overseas commercial operators, is that furnished by the International General Electric Company and the Canadian General Electric Company. These separate companies have foreign offices with sales and service handled in a similar manner as described under domestic district organizations. Overseas airline operators are also contacted by this district through Western Airframe Manufacturers who have their own field and service organization. A great deal of cooperated effort is used to satisfy the overseas commercial operator in this manner. In the case of overseas customers, responsibility for this service is assumed by the International General Electric Company or in Canada by the Canadian General Electric Company, Ltd.

The General Electric products involved with our commercial airline customers are those produced by the Aircraft & Defense Industries. This Aircraft & Defense Industry is made up of several product departments which are similar to individual companies in their operations. The responsibility for these products is at a section level for engineering, design, development, and production. This concludes the General Electric organization for servicing customers.

An important part of effective servicing is knowing customers' organizations. A field service engineer covering a customer's organization knows that maintenance and engineering groups are sometimes separate, and that he will be faced with line maintenance problems or trouble-shooting at some airline sub-station. For these reasons we have available our service memos issued by the Product Departments and distributed by our Aviation Systems engineering section. It is necessary that these service memos go to the proper people who recognize the importance of this information and get it to the correct people involved. Service memos functionally have the status of "do before next overhaul."

The first and only gathering of commercial airline operators, airframe manufacturers with an electrical equipment manufacturer was held at Highland Park, Illinois in March, 1954. G. E. is the only electrical equipment manufacturer who has sponsored this type of meeting. This "state of the art" symposium for commercial airline operators was later published as an Aircraft-Electrical Symposium book. All those who attended have copies. At the present time, additional copies are not available as this book is out of print.

Having covered what, where, and who is involved, I would like to cover how this is accomplished. The General Electric Company has the ability, the men, the materials, and the know-how readily available to accomplish effective servicing regardless of where it is located or the size of the job.

NOSE WHEEL STEERING GEAR and VALVE ASSEMBLY

K. H. Knox .... WESTON HYDRAULICS LTD.

Design of the nose wheel steering cylinders and rack assembly was developed by Convair during the Convair-Liner 240 program. On these airplanes, the steering control (selector) valve was installed in the fuselage. At the inception of the Convair 340 program, the control valve was mounted on the nose wheel steering cylinder assembly, thus eliminating problems of follow-up control and hydraulic plumbing to the cylinder assembly on the nose gear.

Some operators of Convair-Liner 240 aircraft converted the nose wheel steering system to the type used on the Model 340 by modifying the cylinder so as to accommodate the 340 selector valve.

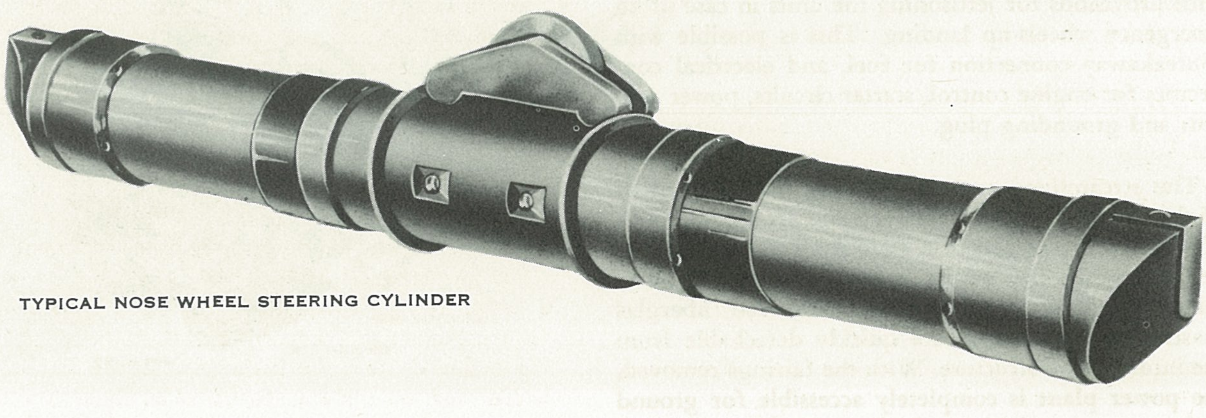
Up to this time, the nose wheel steering cylinders had been designed for grease lubrication on the rack and quadrant. As a result of this process of lubrication, it was felt that some of the wear that was being encountered on the racks and cylinder barrels, as reported by operators of Convair 340 aircraft, was being caused by the presence of dirt being introduced into the cylinder by means of the lubricant.

As a result of this, Weston Hydraulics, Ltd, in cooperation with Convair Service Engineering personnel, entered into a service program to cut down on the wear being evidenced by the presence of dirt. It was felt that the Electro-Film process of molybdenum disulphide coating of the rack and bearing detail parts might be helpful in obtaining this goal. Preliminary results from service tests indicated satisfactory performance.

As a consequence, and at Convair request, a new part number was set up for use on Convair 440 aircraft, covering the "dry lubricant" versions. At the same time, a material of increased hardness was employed in the bearing detail. The Weston number for the molybdenum disulphide version is 14030 for those operators using MIL-O-5606 hydraulic oil, and 14040 for those operators using Skydrol hydraulic fluid. These molybdenum-disulphide-coated details (Weston #13906 bearing and #13905 rack) can be used in the modification of the Weston 10150 and 10410 cylinder and valve assemblies to create the Weston 14030 and 14040 unit numbers.

These detail parts should be interchanged with the old corresponding parts as an assembly since they are not interchangeable separately. In the modification program, it becomes necessary (since the original process of lubrication is no longer required) to remove the NAS2-103 grease fitting, and to plug the grease fitting port in the #13906 bearing of the cylinder assembly with an AN501-416-6 screw and an AN936-A416 washer. This will prevent the unnecessary introduction of dirt into the bearing assembly.

Weston Hydraulics, Ltd will be happy to cooperate with any of the Convair users in supplying the necessary information to perform modification program.



TYPICAL NOSE WHEEL STEERING CYLINDER

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POD-MOUNTED GAS TURBINE
AUXILIARY POWER UNIT

Eric Doorly ...... SOLAR AIRCRAFT CO.

FROM A PAPER PREPARED BY RALPH KRESS

Application of new developments in aircraft equipment for safety, performance, comfort, and all-weather operation have increased the electrical power requirements. The aircraft designer is constantly adjusting for the problems that each new system demands in the form of additional ground and in-flight power requirements from the electrical system. This power must be obtained without drastically affecting airplane performance and/or imposing excessive weight penalties.

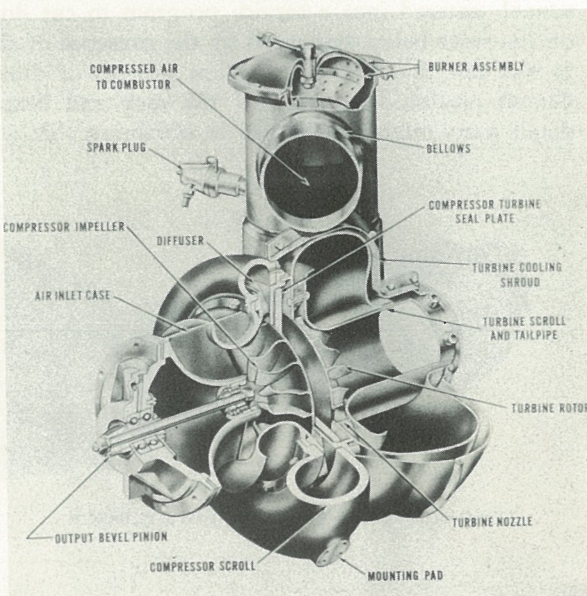
The pod-mounted generator set with a gas-turbine prime mover offers a practical and acceptable solution to the problem of the aircraft auxiliary power source, and gives the designer a fresh viewpoint in his constant search for more "room" in the airplane.

The C-131B, based on the design of the Convair 340, has been used as a test bed to prove various combinations of airborne electronic equipment. In order to satisfy the electric power requirements of various operators and still not handicap the airplane with undue weight, it was decided to install two gas turbine-driven auxiliary power units. Each unit is encased in a streamlined pod, mounted on a pylon under each wing. Attachment is by a standard bomb shackle with provisions for jettisoning the units in case of an emergency wheels-up landing. This is possible with a breakaway connection for fuel, and electrical connectors for engine control, starter circuits, power output, and grounding plug.

The streamlined enclosure, which forms the shell of the pod, consists of a forward and aft section, both of which are attached to a main firewall bulkhead at approximately the 34-per cent chord station. The fairing sections are one-piece reinforced fiberglas plastic moldings which are quickly detachable from the internal pod structure. With the fairings removed, the power plant is completely accessible for ground maintenance, servicing, and adjustment.

Wiring and attaching provisions permit installation and operation of two pods in combinations of two a-c or two d-c units, or one d-c and one a-c pod. The d-c pod-mounted unit (Solar T-41M-5) is rated at 28 volts and has a maximum continuous rating of 17.5 kw from sea level to 25,000 feet. The five-minute overload rating at sea level is 19.6 kw. The a-c pod-mounted unit (Solar T-41M-6) is capable of delivering a maximum continuous rating of 30 kva and an overload rating of 40 kva for five minutes at sea level. In both units, these ratings are for standard and ANA hot-day conditions. In all cases, maximum continuous power output is for the hot-day condition. Maximum turbine inlet temperature is 1300°F; maximum exhaust temperature is 1050°F.

Both a-c and d-c generator sets are powered by a standard Solar Mars 50-hp gas-turbine engine, op-



CUTAWAY VIEW OF TURBINE ASSEMBLY

erating at 38,250 rpm with a pressure ratio of 2.35:1, and an air flow of 2.43 pps.

The unit is designed to start and operate at any altitude from sea level to 25,000 feet, and in ambient temperatures ranging from —60° to +130°F. At sea level, the unit can be up to full speed, carrying full load, within 15 seconds after the start switch is pressed; at 25,000 feet, this can be accomplished in 25 seconds.

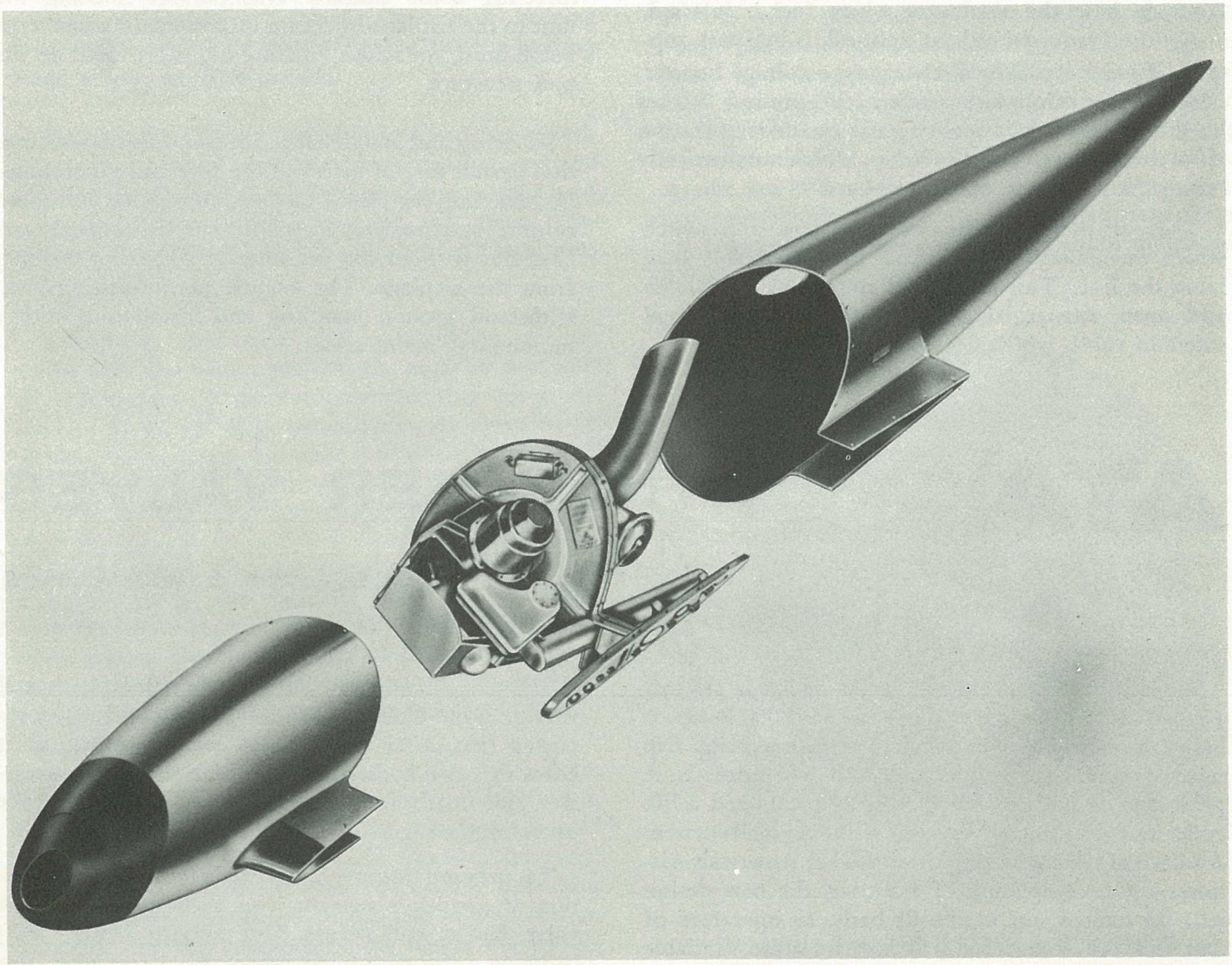
The air inlet at the forward end of the pod is provided with an electrical anti-icing system. Since either a-c or d-c may be used for anti-icing, power is taken from the generator in the pod.

The unit is equipped with self-contained fire detection and extinguishing systems. The fire detectors are of the thermal-switch type, one located in the forward engine accessory compartment and one in the aft turbine compartment. The switches are wired so that continuity of the detection circuit can be checked from the cockpit. The fire detection circuit supplies an indication to the cockpit of high compartment temperatures.

The forward compartment of the pod contains the fire extinguishing agent—approximately eight pounds of bromochloromethane—in a high-pressure spherical container. The distribution system, which is actuated electrically from the cockpit, divides the flow of agent so that both compartments receive equal quantities.

Closing the switch to the C-B bottle automatically closes the nose inlet air door to shut off flow of air into the compartment.

The gas turbine engine employs a single-stage centrifugal compressor, single-elbow combustor, and a single-stage radial in-flow turbine. The compressor impeller and turbine rotor are mounted back-to-back on the same shaft, and are separated by a seal plate.



EXPLODED VIEW OF POD-MOUNTED A-C AUXILIARY POWER UNIT

Coupled to the turbine assembly is the reduction gear and accessory drive. The reduction is accomplished by one set of bevel gears, which allows the use of two main output pads at right angles to the input shaft; one output pad is stepped up from 4500 to 5000 rps so that two output speeds are available. All accessories are driven from the 4500-rpm shaft through an idler gear, the idler gear driving two accessory gears. Since idler gears, accessory gears, and main bevel gears are at right angles to the input to the gear box, two accessory drive pads are available from each of the accessory drive gears.

The four accessories driven from the accessory pads on the gear box are the main governor-fuel pump combination, overspeed switch, tachometer generator, and the lubricating oil pump.

OPERATION

Inlet air enters the compressor through a screened annular opening. The scroll encircling the compressor collects compressed air delivered by the diffuser and conducts it to the combustor where fuel is injected.

Ignition, required only at light-off, is by spark supplied from a capacitor discharge-type voltage booster. The start switch, when momentarily pressed, latches in the starting relay, initiating the cycle for operation of a series of relays and switches, which automatically bring the turbine to operating speed.

The unit is stopped by operation of a stop switch which momentarily disconnects the electrical system from the line. This allows the start relay to unlatch and open, deenergizing and closing the main fuel solenoid valve, which decelerates the unit.

Safety monitoring controls are provided on the unit to stop it in cases of turbine overspeed, tailpipe overtemperature, low oil pressure, and burner flameout. Visual indication is also provided for high and low oil temperatures, low fuel pressure, and fire warning.

Lubrication of the gear box and turbine rotor shaft is provided by an oil pump driven from one of the accessory pads. An integral sump in the gear box provides cooling of the lubricating system. No external oil cooler is used.

Oil is taken from the sump by a gear-type oil pump and then delivered to the oil filter. From here, it goes through a relief valve to the main jets. Lubricating oil used in the system meets the requirements of Specification MIL-L-7808.

MAINTENANCE

The pod is attached to the airframe by means of a three-lug bomb shackle. This permits hoisting the unit to the airplane by means of a standard winch type bomb hoist, for which a lifting eye is provided on the pod structure.

Servicing and maintenance are simplified by features that permit ease of access to the fore and aft sections. By removing the plastic fairings, the engine and speed control systems are accessible for adjustment and checkout without the necessity of removing the unit from the airplane. The rugged plastic fairings will withstand ground handling and installation with a minimum of maintenance.

ATA WHITTAKER VALVES

Jack O. Kelty .... WM. R. WHITTAKER CO.

An improved solenoid pilot-actuated sleeve selector (P/N 118045), designed to operate for 8000 hours, is being developed at Whittaker to replace existing flap selector valves on Model 240 and 340 aircraft. A prototype of the new valve recently completed a life cycle test of 100,000 cycles without malfunction. Additional tests are being conducted at American Airlines. Upon completion of the tests, the new design will be offered, on a retrofit basis, to operators of 240 and 340 aircraft. It will also be made available for T-29 and C-131 Models.

Our most recent service problem has been in regard to the manually-operated fuel and engine oil shutoff valves. Both United Airlines and Braniff have reported that, after an extended service period, shaft bores in valve bodies become elliptical, due to excessive side loads induced on the valve shaft by the operating linkage.

To prevent this wear, we recommend the installation of corrosion-resistant steel bushings in both the valve bodies and covers. Our Service Letter, 56-1, contains information necessary to accomplish this modification. Bushings may either be manufactured locally or procured from our company.

ATA PRIMARY COMPRESSOR

Joseph A. Cannell ..... AIRESEARCH MANUFACTURING CO.

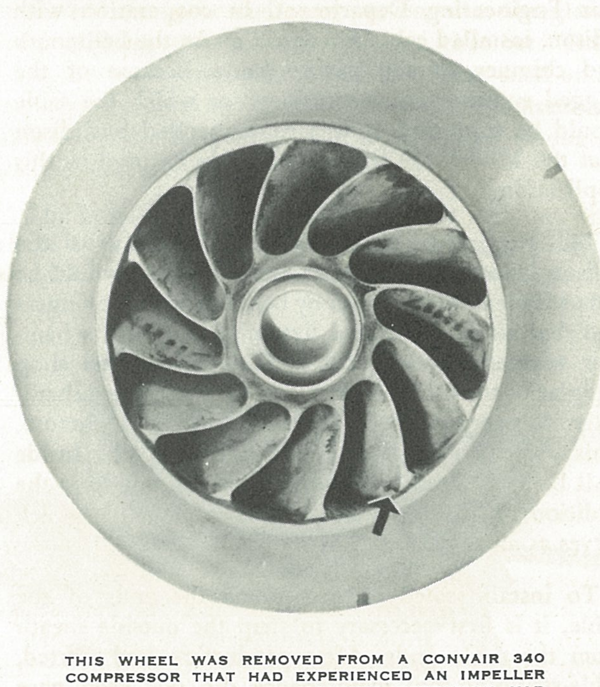
The AiResearch primary compressor on Convair 340's does not appear to present any major chronic problems; however, there are several items on this unit that merit some consideration. The first of these concerns impeller bearing failures. During the early days of compressor operation, it became evident that the original bearings would not consistently do a satisfactory job. AiResearch, working in close cooperation with the bearing manufacturers, conducted an extensive program to improve bearing performance. During this program, more than a dozen different type bearings were tested. Finally, two bearings that seemed to offer the ultimate in service life were selected. These were a "New Departure" bearing with AiResearch P/N 205154, and a Barden bearing with AiResearch P/N 205483.

Shortly after adoption of these bearings, we experienced several bearing failures. Investigation revealed that the bearing carriers contained large amounts of dust. Field investigation indicated that these compressors had been operated in areas where dust storms are prevalent.

AiResearch then developed an impeller seal arrangement that would prohibit the entry of dust into the bearing area. It was recommended that this modification be incorporated on compressors operated by airlines whose routes traversed dust storm areas. After the seal modification, we still experienced scattered cases of bearing failures. It was noted, however, that the impellers of these failed units contained heavy deposits of dust. The dust apparently builds up in a uniform manner and does not initially affect wheel balance; however, by the impingement of rocks or other causes, the dust can be knocked free from a portion of the wheel. When this occurs, the resulting unbalance can be sufficient to cause bearing failure.

A service test was inaugurated on the fleet of one Convair operator. On one-half the operator's fleet, the inlet duct was removed and the dust was removed from the wheel at approximately 100-hour intervals. On the other half of the fleet, no cleaning operation was performed. The results of this test were somewhat amazing. On the compressors on which the wheels were not cleaned, approximately eight failures were experienced, half of these being impeller bearing failures. On those compressors on which the wheels were cleaned at regular intervals, there not only were no impeller bearing failures, there were no failures of any type. All 12 compressors went to full time. In view of this, it is our suggestion that those airlines who operate in dust storm areas make provision to inspect and, if necessary, to clean impeller wheels at regular intervals.

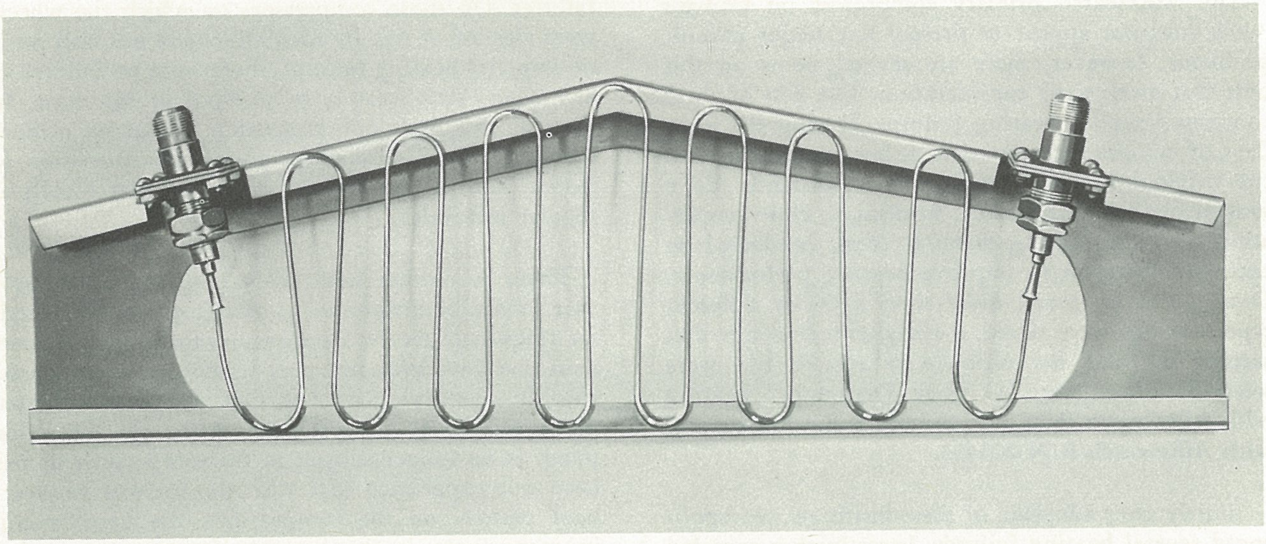
There is another item concerning the compressor that should be mentioned at this time. At AiResearch we frequently receive compressors for repair or overhaul that have been removed because of low oil pressure. In many cases, we find that changing the Pesco pump eliminates the problem. Although the Pesco pump is no longer subject to failures as such, it has been our experience that with the increase of overhaul periods on the compressors, the Pesco pump in many cases is the limiting factor on extended service life. We would suggest, therefore, that wherever possible, the Pesco pump be changed rather than the complete compressor, upon indications of low oil pressure.



THIS WHEEL WAS REMOVED FROM A CONVAIR 340 COMPRESSOR THAT HAD EXPERIENCED AN IMPELLER FAILURE. NO REGULAR CLEANING OPERATION HAD BEEN PERFORMED.

CABLE FIRE DETECTION

F. E. VanCleef Jr. .... THOMAS A. EDISON, INC.



In an effort to improve the overall fire detection coverage on the Metropolitan 440 airplane, the Convair Engineering Department, in cooperation with Edison, installed cable fire detectors on the bellmouth and chimney of the power plant. Because of the rugged environmental conditions to which the cable would be subjected, it was recommended by Edison that the Model 239 ruggedized cable be used in this application.

This ruggedized cable was the latest result of the Edison laboratories to provide a cable that would be almost impossible to break by bending with the fingers and that would withstand flattening out with a hammer without adverse effects. The early model shop samples of the cable showed it to be superior mechanically to any previous cable of Edison manufacture. This particular cable has a double wall, the inside wall being the same as previous cables, but with the addition of an extremely tough outside wall, which serves as an armor coat for the cable.

To install sealed connectors on the ends of the cable, it is first necessary to strip the outside sheath from the cable ends. After production had started, cable-stripping-tool maintenance did not keep pace with the more rigid requirements placed on the tool and, as a result, some cables included metal particles. Previous experience with many thousands of other cables did not show inspection to be necessary at this state of the fabrication process. Thus, the Edison production technique failed on two counts . . . tool maintenance and inspection . . . for which Edison has taken full responsibility.

Having recognized the exact nature of the difficulty, improvement of cable stripping techniques and insertion of a rigid inspection step, prior to assembly, has eliminated this difficulty, and successful test cables have been fabricated. No radical tooling production or assembly changes were or are necessary to eliminate this problem. Proper stripping-tool maintenance and rigid inspection have done the job.

The loose particles in the cable were discovered after a very thorough investigation to determine the cause of several false alarms which were encountered by Convair and Continental Airlines. Because of the urgency of the problem, there have been many questions raised as to the reliability of the cable under vibration and rough treatment. There has been no evidence to show that anything other than loose particles, in a very small percentage of the cables, was the cause for malfunction.

The ruggedized cable, manufactured with the improved techniques will also include a new strain relief where the cable terminates into the end connector. The part number has been changed to Model 264 to identify the new cable. Hereafter, the bellmouth cable will have the number 264-54G43. These new cables have been subjected to considerable testing and are ready for production.

In addition to improving the ruggedized cable design, a new grid assembly for mounting below the chimney has been designed by Edison and submitted to Convair for approval. This assembly (see photo) consists of the new Model 264 cable, which has been brazed in a grid pattern onto a stainless steel bracket assembly. This assembly will facilitate installation and will be more dependable than the former type. Not shown in the photo is one minor change. This change is the substitution of right angle termination connectors in place of the straight connectors shown in the photo. This new grid assembly has been given part number 41497.

All Model 239 bellmouth and chimney grid assemblies are being replaced by Edison at no charge.

Edison wishes to express appreciation for the patience and constructive criticism offered by Convair and Rohr during this period. These suggestions have been carefully considered, and operators can be assured that strict quality control is being observed on all cables now being manufactured at the factory.

ATA EXHAUST MUFFLERS

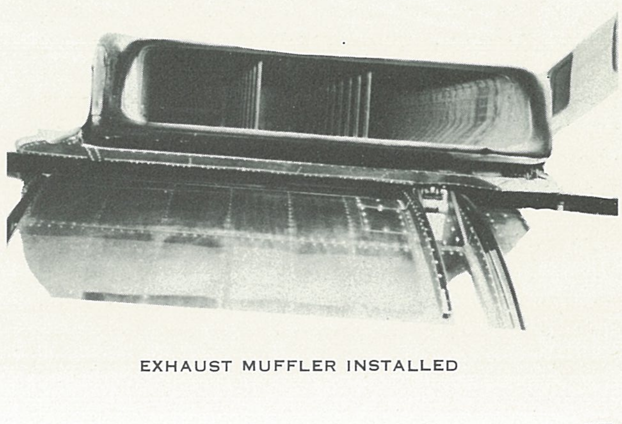
Donald H. Ester .... AIRITE PRODUCTS, INC.

Airite has participated only in the production of the exhaust mufflers on Convair 340 and 440 aircraft and not with their installation and performance. However, data obtained from our production experience may be useful to the operator regarding maintenance and overhaul. The illustration shows a unit with the top cover removed to show the packing and interior construction of the muffler unit. Basically, the unit consists of two assemblies — the transition assembly and the muffler unit, itself.

The transition assembly is used to change the circular gas flow pattern into a rectangular pattern as it goes into the muffler, where the sound energy can be absorbed and dissipated. The transition assembly of rugged construction consists of a .064 wall thickness duct in two sections, reinforced by .040 stainless ribs at two stations on each duct, and a frame welded thereto, which is attached to the muffler. The vanes and levers regulate the gas temperature in the augmentor tubes for the purpose of cabin heat and anti-icing.

The muffler itself consists basically of a perforated tube, or inner shell. Surrounding this is a series of 19 full frames and one half frame, which provides the structural strength necessary to support this perforated inner shell. The outer wall of the inner shell is covered with a Monel screen tape, approximately two inches wide. This screen covers the holes perforated in the inner shell, and prevents the fibreglass from shifting through into the gas chamber. The fibreglass is then packed between this inner shell and the outer removal covers and side skins. It is used to absorb the sound energy that is dissipated through the perforated skin.

The removable cover and the support structure on the bottom side of the muffler were made on tooling, designed to produce interchangeable parts so as to



EXHAUST MUFFLER INSTALLED

facilitate any necessary spares program. This is true of all removable components.

The trailing edge cap assembly is made of as few pieces as possible to accomplish its purpose, and is assembled into one unit in a manner designed to produce an interchangeable assembly. This assembly is riveted onto the muffler shell proper and, although no extreme service requirements regarding spares should be anticipated, an interchangeable assembly could be furnished.

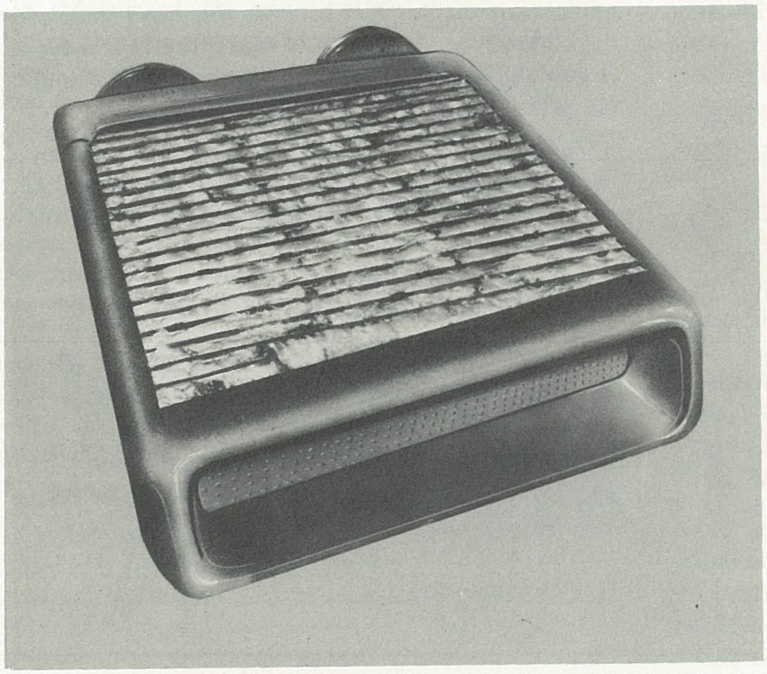
On our production line we have had no occasion to disassemble and repack a muffler such as operators will have to do in service; therefore, I am unable to give an estimate of what this time would be. However, of some value to the operator may be the average time it takes us to pack and cover a muffler, since this procedure contains all the time necessary for such a service operation, with the exception of the initial removal of the covers and old fibreglass. The time for this operation in production is 8½ man-hours; this time includes installation and use of plasti-seal; installation of the bolts, struts, and strut bolts; and individual torquing of each bolt.

Of interest also will be our time of 2½ man-hours to install the transition assembly to the muffler proper; this time includes the installation and use of the plasti-seal, the braided seal strip (which is installed between the two units), and the top and bottom fire seals. I might point out that, on production, it is necessary to leave out the fairing struts, until after the transition has been installed. This is necessary because a slight over-torquing of the ¼-inch bolts through these struts will distort the bolt pattern on the face of the muffler sufficiently to make it almost impossible to install the transition. In fact, it has been found that the best practice for installation is to install the front two struts and bolts only, and to adjust the length of these bolts until the exact dimension across the bolt pattern is obtained and agrees with the jig-drilled holes in the transition. After installation of the transition, it is possible to proceed with the installation of the top and bottom covers and the balance of the struts and cover bolts.

The Convair Engineering Department is responsible for the detail design and engineering on this unit, and in our opinion have done an excellent job. Convair, likewise, hand-built the first two ship-set assemblies. The only changes that have been made to the original design, since Airite began production almost a year ago, have been changes designed to produce an equivalent or better part in a simpler manner, and these changes have been few.

With regard to the service life to be expected from the fibreglass packing, we at Airite have no information except reports that some of the first installations have attained as much as 1000 hours service life.

In regard to sound-deadening capabilities of this unit . . . each item of the sound reduction program is so interrelated with the other items that the gain to be realized from the muffler alone cannot be estimated in decibels; however, the mufflers are expected to provide maximum benefit at the rearmost seats.



MUFFLER UNIT
WITH TOP COVER REMOVED
TO SHOW FIBREGLASS PACKING
AND CONSTRUCTION

WINDSHIELDS AND CABIN WINDOWS

A. V. Johnson
PITTSBURGH PLATE GLASS CO.

I will try to describe the progressive design of 240, 340, and 440 windshields and cabin windows on the Convair 440. *Windshields on the 440 are approximately the same as on the 340.* Improvements in windshield design from the 240 to 340 were made possible through the patience and tolerance of airline operators, aircraft manufacturers, and others during the development of NESA glass. In the early years — 1946 to 1950 — many types of failures were experienced, and a term such as "Nice Effort, Start Again" was given to the letters, NESA. Actually NESA stands for "Non Electrostatic Solution A." Although it was called an "Engineer's Dream" or a "Maintenance Man's Nightmare," I believe you will agree with me that NESA does do some things very well.

Aircraft manufacturers through the years have used several methods of maintaining clear vision on transparent areas . . . hot-air systems with double glazing; wires imbedded in the vinyl interlayer, and alcohol flush systems. Finally, NESA coating came along and seemed to be the answer to our problem.

The hot-air system had more disadvantages than advantages. It required full-tempered outer-ply glass, plus air space, plus laminate, which resulted in a weight penalty. Although double reflections in the glass were annoying to pilots, the overall optics were fair to good.

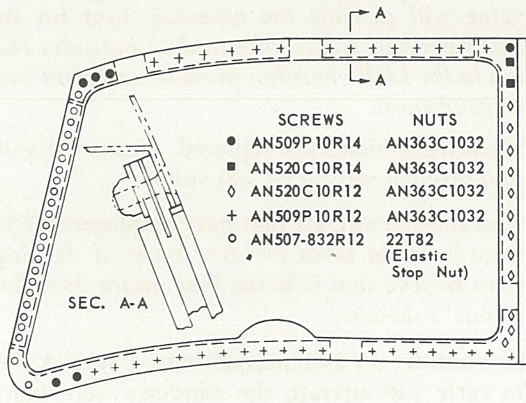
Wire imbedded in the vinyl required high power input with resultant localized non-uniform heating and distortion.

The alcohol flush was very effective and did not require a weight penalty in the glass.

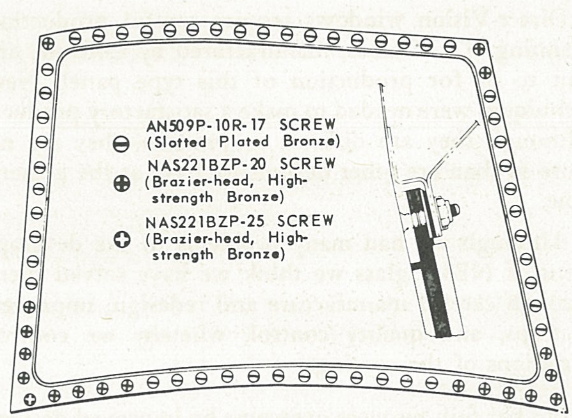
NESA coating appeared to be the answer to many problems. It has efficient heat conduction because of its surface coating; there is very little reduction in light transmission; optics are comparatively good; and the weight increase over most other systems is negligible. In fact, when compared with those systems that require installation of hot-air ducts up to the glass, a considerable saving in weight is realized.

Design is generally a compromise between what the engineer would like to have and what can be produced at the time that design is set. Thus, it is important that we work directly with engineers in early stages of design so that we can combine their design requirements with our processing.

The Convair 240 design represented the best thinking of everyone concerned at the time of its inception. It followed the usual design of the period with flex seal glass . . . the Convair 240 being the first of NESA designs for commercial aircraft. The



240 WINDSHIELD



340 WINDSHIELD

first windshields utilized Type A design, wherein both plies of glass were of equal length, and the vinyl extended beyond the metal insert. All mounting was done on this extended edge. This meant that under pressure the vinyl edge with metal insert imbedded had to take the pressure load. Since the metal insert had to continuously act as a ply between two layers of glass, there was a tendency toward delamination. Upon pressurization of the aircraft, the assembly had a tendency to give outward — sometimes as much as 1/8 inch. Bus bars were located in such a manner that hot spots were formed, tending to break the glass.

With the 340 design, an entirely new conception of glass assembly was applied to the form of the type B flex seal. The inboard ply on these assemblies was larger and thus capable of bearing the load, and were less susceptible to delamination.

A metal insert was used in two ways: it was either extended between two glass plies or it was left outside the outboard glass. Both designs have been used and both seem to work very well. Installation of the Convair 340 windshield is simplified with outboard mounting. The outboard retainer ring is bonded to the assembly, and jig-drilled for interchangeability. The outboard mounting eliminated the necessity for cutout for windshield wiper, thus reducing tendency of the glass to break due to high heat accumulations. The use of spacers or bushings minimized the tendency for clamping too strongly on the vinyl; thus, the installation is less susceptible to delamination.

The 340 design with low and high heat settings is one of the best designs in use. It is advisable to operate on the low heat as much as possible and keep it turned on at all times that icing is expected. If the system is not operated until icing conditions are entered and then is set directly to high heat, the rapid change in temperature induces stresses on the glass. The vinyl layer requires maintaining temperatures somewhere between 80 and 110° for best delamination-resistant qualities.

Direct-Vision windows require careful production planning. The frames, manufactured by Convair, are sent to us for production of this type panel. New techniques were needed to make a satisfactory product. Although they are difficult to produce, they are no more so than are other designs we have at the present time.

Although we had many problems in the development of NESA glass we think we have solved them through careful manufacture and redesign, improved coatings, and quality control, whereby we control variations of the coating.

Bus bar failures were overcome by improved design; peeling of the coating was eliminated by manufacturing control; breakage of the outer ply was overcome by improvement of the degree of temper; blind-tapping of the terminal blocks eliminated mistakes in installation.

A method was found for detecting surface scratches that were so small that they could not be detected with the naked eye. These scratches tended to cause local hot spots.

If I were asked what one improvement is outstanding, I would say, "the improvement in the accuracy for holding tolerances." This requires accurate tooling, both that supplied by the manufacturer and that used in production. NESA windshields in service have shown an increase in resistance with no other apparent defect. Operators have suggested that power dissipation, and not resistance alone, be used as a criteria for acceptability of NESA windshields.

To determine acceptability of such a procedure, windshields showing high resistance were returned to us for examination and testing. Examination and testing indicated the following: 1) "K" values checked within the limits of error of measurements, 2) there was no breakdown of the NESA adjacent to the bus bar, 3) there were no indications of hot spots, and 4) the soldered joint of attaching wire braid was good.

In view of the condition of the returned wind shields, it was determined that resistance increase is not indicative of the development of the localized hot and cold spots which would act as stress risers and which might cause failure of the glass. Increasing the applied voltage to maintain the original power dissipation would be a satisfactory procedure, and an increase in applied voltage is limited by the practical design of the transformers.

Considering the condition of the high-resistance windshields, the following is suggested:

1. Increase the voltage to the glass to 310 volts so as to maintain a minimum power input of 900 watts to the glass.

2. Ascertain by actual service that the higher resistance value will provide the necessary heat for the individual operator. *Experience to date indicates that operation in the LOW position provides sufficient heat for most conditions.*

3. When windshields are replaced, return the voltage to the original setting of 290 volts.

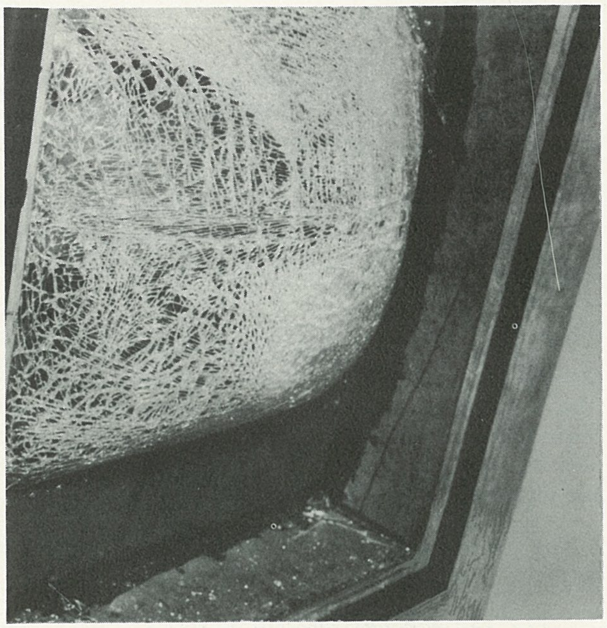
The fact that no aircraft that have employed NESA have discarded it in favor of other types of de-icing, leads us to believe that it is the best means available for windshield de-icing.

Cabin windows on 240 aircraft have a type A flex seal. On early 240 aircraft, the windows were fabricated with a non-continuous metal insert. While some

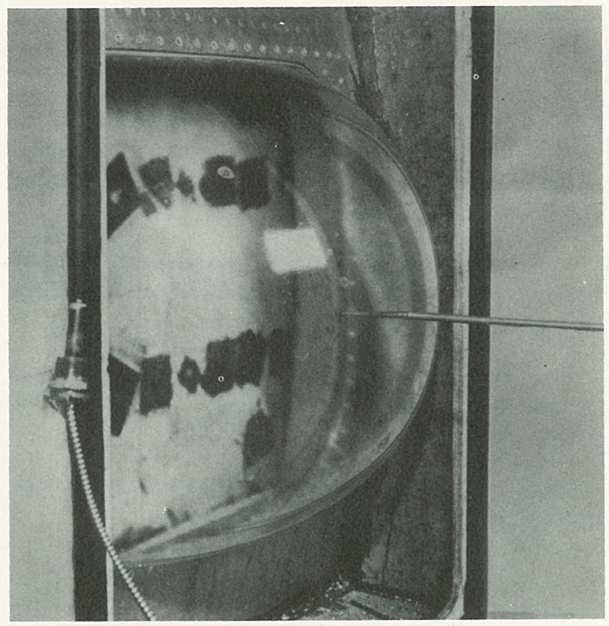
windows of this type are still in service, all replacement spares have a continuous insert. The continuous insert was designed primarily to provide more gripping area on the vinyl plastic in the event of failure of the pressure-bearing ply of glass, which holds the vinyl plastic in tension to prevent blowout of the panel.

On the Model 340, the inner pane of glass is approximately .50 inch larger in overall dimension than the outer glass, a feature that provides added safety under pressurized conditions. An improved installation makes use of metal spacers in the extended plastic edges, which makes progressive tightening and further cold flowing of the vinyl plastic impossible.

Tests were conducted by Pittsburgh Plate Glass and Convair to discover the effects of high temperature and excessive pressure on the window and lamina installations, and to ascertain the effect of various heat and pressure combinations. Under the test conditions, all failures occurred with relatively slow decompression and in no case, under extreme heat and pressure conditions, did a blowout or explosion occur, confirming Convair's and Pittsburgh's concept of passenger window integrity. The photographs below were taken during tests at Convair to determine the integrity of the window glass and vinyl.



WINDOW SAMPLE—AT 10.5 PSI AND 80°F. AT PRESSURE INCREASE RATE OF 6 PSI/MINUTE. WINDOW BALLOONED SUDDENLY WITH SEVERE SHATTERING OF GLASS, BUT NO VINYL FAILURE.



VINYL SAMPLE—9 INCH DEFLECTION AT 90°F AND 10 PSI. FAILURE OCCURRED AT DEFLECTION OF 11 1/2 INCHES AFTER 12 MINUTES. VINYL TORE RAPIDLY ALONG BOTTOM, ACROSS CORNER, AND UP LEFT SIDE.

ATA PESCO EQUIPMENT

Harold Daelcher.... PESCO PRODUCTS

As a result of repeated reports of cracking of pump castings, Pesco changed from an aluminum sand casting to a forge type casting. To the best of our knowledge, this eliminated the cracking problem.

Bearing seizure problems in the pump unit were also reported. Pesco determined that the cause for seizure was due to poor bonding of the silver-plated bearings; however, there was no way of inspecting these bearings to make sure that the silver was bonded properly to the steel backing. Development of a new tri-metal bearing has eliminated bearing seizure. These are the two changes initiated by Pesco to improve service life of the pump.

Approximately four months ago, Pesco investigated reports of excessive internal leakage of the pumps in the AiResearch compressor. The following recommendations were made by Pesco and these recommendations are now being used in the field with good results.

It was determined that a high inlet surge caused leakage and the inlet surge upset pressure-loaded bearings. Pesco recommended that, during overhaul, a spacer (Pesco P/N 01-10802) be placed on the top of the flange of the cover bearing to reduce the clearance which was originally required in this unit when it was being used as an unloading pump. Since this unit is no longer being used as an unloading pump, this clearance, which allowed the bearings to move away from the gears during a high inlet surge, is no longer required. Caution should be taken, however, when this spacer is installed in the unit, to make sure that .002 to .003 inch clearance is allowed between the spacer and the cover so as to provide proper loading. A Pesco Service Bulletin is being prepared to cover this change.

Pesco Engineering Department is in the process of modifying the flange and cover to eliminate the necessity for these spacers. The modification will include the following features:

1. Fretting, which is now evident on the steel bearing journals, will be reduced by elimination of anodizing of body and cover bores.

2. Off-set loading of the cover bearings will equalize the forces against the bearing and allow better alignment between cover and bearing.

3. Loaded springs will help prevent the bearing from unloading at high inlet pressures.

Note

Pumps should not be operated if inlet pressure is higher than discharge pressure.

Pesco will provide five or six of these units for testing by AiResearch within the next 30 to 60 days.

An improvement in the Pesco hydraulic pump (012082-010-05) was effected by a change in the processing of the seal on the drive end of the pump. The process change consists of an aging period before finish-lapping of the seal. No reports of trouble have been received since this change in the seal.

Those operators experiencing wear of the drive and bearing liner of the fuel pump motor (P/N 220035-100-10) may machine out the old liner and machine a replacement; then finish-machine the replacement liner in the motor casting.

Caution should be taken to make sure that the bearing bore, when completely machined in the casting, lines up as closely as possible with the pilot on the castings so as to prevent unequal loading on the bearing and gear head. Since part number 22-3211 requires many machining operations before it can be used on the motor, Pesco recommends that Part Number 122-3209 be ordered because it is already drilled.

Fuel on the adjusting screw side of the diaphragm of Pesco fuel pump (2P-771-CE-1), as experienced by one operator, is unlikely if diaphragms are not ruptured or pin-holed, if mating housings are free from nicks,, and if screws are properly tightened. Pesco suggests that operators check the possibility of fuel entering through the supercharger connection.

Pesco Products Division, Borg-Warner Corporation, has established a West Coast Plant, which is now under Air Force cognizance. It is known as Pesco Pacific Service Center, located at 5521 Cleon Avenue, North Hollywood, California. Being owned and controlled by Pesco, this plant is operated under the same quality control as is Pesco in Bedford, Ohio.

Pesco Pacific Service Center is equipped to overhaul and test any item which is manufactured by Pesco. The main function of this plant is to give Pesco's West Coast customers prompt service and to eliminate the valuable time lost in transportation of units for service from the West Coast.

The following test facilities are available in this plant:

D-C and 400-cycle generators which enable us to test any motor-driven unit.

Three variable-speed test stands for testing small engine-driven units.

A 150-hp Dynamometer, installed in an explosion-proof equipped room, which enables us to test jet engine-driven fuel pumps with JP4 fuel, under the proper conditions before installing on a jet engine.

There is also installed in this explosion-proof room, a fuel booster pump test stand which enables us to test five different types of pumps at one time or five of all the same type.

Pesco Pacific is now in the process of installing altitude equipment to enable us to test hydraulic and fuel systems under altitude conditions.

Thus, Pesco Products offer facilities to aid you in your aircraft programs. Please let us know if we can be of any service to you.

ATA

RYAN EXHAUST SYSTEM

C. L. Fouché Jr. .... RYAN AERONAUTICAL CO.

Exhaust stack weld assemblies are manufactured by Ryan from 19-9DL corrosion-resistant material, using gages .050, .063, and .078. The port nipple on the rear cylinder has a wall thickness of .156 and the front cylinder nipple assembly wall thickness is .125. Depending upon the operator's requirements, the complete assembly may be ceramic-coated. The front cylinder extensions and front cylinder extension flanges are manufactured from 18-8 type 347 material. The stand-off brackets are manufactured from 1095 spring steel, heat-treated to 180,000 - 200,000 psi. The outlet and figure-8 clamps basically are manufactured from 19-9DL corrosion-resistant steel of .063 thickness.

INSPECTION

One of the most important items for maximum service life of the exhaust system components is adequate inspection by the airline operator during normal service periods. Normal service inspection should require the checking of all hardware, excessive leakage at slipjoints and flange joints, and the checking of exhaust port studs. The overhaul period inspection should consist of checking the individual components for material thickness, indications or signs of cracks, and for worn and galled areas. After parts have been overhauled, as recommended by both Ryan and Convair, a dimensional check of the detail components should be made to insure proper fit of slip joints and other mating surfaces.

MAINTENANCE

Overhaul, repair, and alignment of the exhaust system components is vitally important. The following items are recommended:

1. Heat-treatment should be accomplished as recommended in the Ryan Exhaust System Service Manual.

2. Sandblasting should be confined to the areas recommended by Convair and Ryan, and under no conditions should the sandblast pressure be more than 40 pounds.

3. Parts should be repaired as necessary, using only recommended repair methods. There are nine repair kits available to airline operators to cover those repairs which are economically feasible.

4. The alignment of the exhaust stack components, particularly the stack weld assemblies and the front cylinder extensions, is very important. It has been proved by most airline operators that in-service failures can be eliminated and longer service life of the components can be realized, if each component is properly aligned. Likewise, less man-hours are required to install exhaust system components after overhaul.

SERVICE LIFE

At present, the main problem being encountered is the tightening procedure being used on the figure-8 and outlet clamp assemblies. It is recommended that the procedures as outlined by Convair and Ryan be followed. The primary difficulty has been with the over-tightening of the figure-8 clamp. This causes an out-of-round condition in the clamp wearbands, resulting in wearband failures, clamp body failures, and clamp bolt failures. Another item which frequently occurs is that of chafing of adjacent stack weld assemblies, caused by misalignment of the exhaust components at overhaul and by improper tightening procedures. Considerable concern is caused by cracks which occur adjacent to the weld of the saddle patch radius. It is expected that this condition will be eliminated with improved manufacturing techniques.

The last item causing concern among a number of operators in recent months is that of the hardware used on the exhaust system. It is recommended that hardware items, as called out on the parts list, be used with the exhaust system.

The average service life of the various components is as follows:

1. At present, the average life for stack weld assemblies is approximately 7000 hours.

2. The front cylinder extensions have an average maximum life of 4,500 hours.

3. The front cylinder extension flange assemblies (P/N 12007-200) average from 1500 to 3000 hours.

4. A certain percentage of stand-off brackets (P/N 60261-3), which are expected to last one engine period, have been removed due to failures caused by excessive erosion or notches on the edges of the bracket.

Ryan is currently conducting service tests on three different bracket designs. Their target is to produce a bracket which will be satisfactory for one engine change period. Commercial operators check the installation each time the cowling is opened, and schedule changes for units which indicate signs of early failures. The stand-off bracket is considered a one-time item and, when once removed, is scrapped—never reinstalled on an engine.

It is recommended that high-temperature lubricant (Fel-Pro C-5) be used on all slip-joint surfaces. This lubricant has been found highly satisfactory in reducing wear and seizing at slip-joint surfaces.

Service life of the exhaust system components is dependent upon the proper inspection, repair, and alignment of the individual components.

At the present time, considerable effort is being devoted to solving the problem of erosion on the front end of the front cylinder extension. Service test programs are being contemplated, using various materials on the front end of the extension, to either reduce or eliminate the erosion problem.

The last item being considered under service test and development is the front cylinder flange assemblies. This problem is basically one of corrosion, coupled with a slight wear problem. It appears, however, that a change of material may be necessary to eliminate the corrosion problem, which is taking place and reducing the life of this part. In the near future, it is expected that service test parts will be furnished to airline operators.

ATA LANDING GEAR

G. E. Vescelus... MENASCO MANUFACTURING CO.

Dirt and water in the main landing gear packing bore area under the gland nut has created corrosion problems. An inspection for this condition was recommended in Convair Service Newsletters 243 and 266 so that remedial action could be taken at the operators' earliest convenience.

The specific cause of corrosion has not been isolated; however, moisture, high chloride concentrations, and contact between dissimilar metals may all be contributing factors.

A recommended repair consists of adding an "O" ring to the lower bearing (P/N 528063), cadmium-plating the bore in the outer cylinder (P/N 528000 or 528400), and drilling four drain holes in the gland nut (P/N 528062). Cadmium-plating is specified because this treatment provides better corrosion protection than does chrome-plating. In addition, cadmium-plating is easier to apply, requires no grinding, and is less expensive.

No reports have been received of corrosion on struts repaired in accordance with instructions in Newsletter No. 243; however, the procedure presented in Newsletter 266 and repeated here is considered more effective and economical than is the procedure in Newsletter 243.

Operators who have already incorporated the repair specified in Newsletter No. 243 should also rework the lower bearing, packing adapter, gland nut, and shock strut assembly, to insure that no further corrosion is experienced.

In all other instances, the following repair procedure is recommended with the strut disassembled.

CYLINDERS
528002 and 528402

Repair cylinders by hand-blending sharp surface irregularities in the corroded gland area to prevent damage to the "O" ring during assembly of the strut. Clean and cadmium-plate the gland area on the 5.750 diameter. Plate per QQ-P-416, Type 1, to a diameter of 5.750/5.753. The pickling procedure will insure the removal of all corrosion products. Bake at 375°F ±25° for a minimum of three hours.

LOWER BEARING
528063

Rework lower bearing to incorporate an "O" ring groove as shown. Replate lower bearing with cadmium per QQ-P-416, Type 1. Do not plate inside diameter or the "O" ring groove on the inside diameter. Spray on and air-dry a coat of resin-bonded

molysulfide lubricant (Lubri-Bond, produced by Electro-film Corporation, 7116 Laurel Canyon Road, North Hollywood, Calif.).

PACKING ADAPTER
528062

Spray on and air-dry one coat of resin-bonded molysulfide lubricant.

GLAND NUT
528062

Rework to add drain holes as shown.

MLG SHOCK STRUT ASSEMBLY
528000 or 528400

Assemble the strut. "Butter" the AN6230-32 "O" ring before installing it over the 528063 bearing, and before placing it in the packing bore. Bottom the gland nut and then tighten to next locking position. This is a variation from previously published procedure and must be accomplished to preclude wear on the cadmium-plating.

We have had reports that Skydrol has been damaging fibre insert locknuts on the apex bolt. We recently converted to an all-metal Flexloc nut to prevent this difficulty.

We have not encountered corrosion on the nose gear packing bore, but to be on the safe side, we are now plating this area.

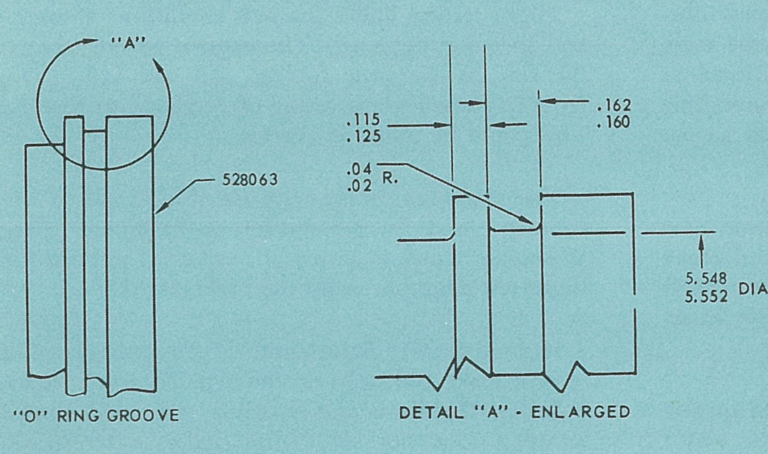
Other improvements to the nose gear include: 1) the addition of removable and replaceable wear plates on the steering collar (Convair Service Bulletin 340-143); 2) painting the entire gear with Skydrol-resistant paint; 3) closer tolerance control on shock strut cylinder stops.

We have also had reports of shock struts going flat during winter operations. This may be due to the packing; however, we are using "O" rings in the standard manner, and can offer no definite solution to this problem. More squeeze on the packing may alleviate this difficulty.

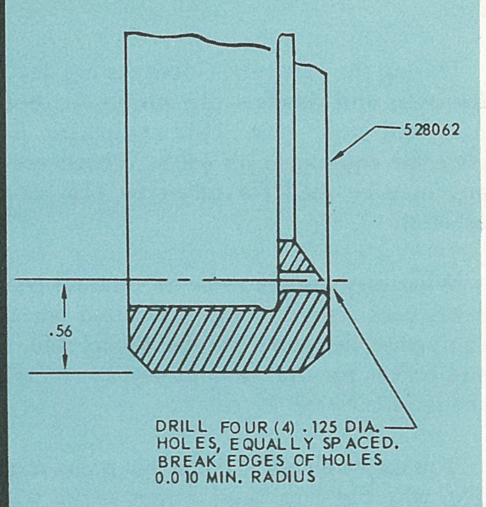
Decreasing the size of the "O" ring from the conventional 6227-56 to a -55, may eliminate the problem. The "O" ring was expanding and, under this condition, would no longer form a bond or seal against the outer diameter of the piston. Western Air Lines has found this a satisfactory solution.

Hawaiian Airlines, who use nitrogen instead of air in the struts, have had no strut problem. The Air Force has had difficulties when operating from arid to cold climates. Northeast Air Lines who operate in -40°F temperatures use oil-pumped nitrogen and have experienced no difficulties. Prior to this, NEA felt that nitrogen may have caused the difficulty. These reports from operators indicate that more frequent shock strut servicing may be required during cold weather operation.

We would suggest that Convair act as information-gathering center and, as each operator accumulates time and experience, forward the information. Maybe we can get some kind of definite pattern so that the problem can be solved.



LOWER BEARING REWORK TO INCORPORATE "O" RING GROOVE



GLAND NUT REWORK TO ADD DRAIN HOLES

WHEELS AND BRAKES

Ed Wilder ..... GOODYEAR TIRE & RUBBER CO.

Consistent with the growth of the Convair airliners, the Goodyear tires, wheels, and brakes have increased in capacity and performance. Beginning with the Convair 240, our company provided the 34 x 9.9 tire, wheel, and brake. The loads imposed on the equipment were in the neighborhood of 10,500 lb static per wheel and 3 million ft-lbs kinetic energy per brake.

With the advent of the Convair 340, the tire size changed to 12.50-16 to provide somewhat greater flotation and better tire life. New wheels and brakes were, of course, manufactured. The new equipment was qualified for the increased wheel and brake requirements of 11,250 lb static load per wheel and 3.38 million ft-lbs per brake.

When the airplane grew to the present 440 configuration, we manufactured an aluminum housing brake with a slightly thicker disc to compensate for the increased requirements imposed by the new airplane . . . 12,000 lb static per wheel and 3.6 million ft-lbs kinetic energy per brake.

The wheels and brakes for this series of aircraft are similar in configuration, performance, and service. All wheels are of the bolted half, cast magnesium style, while the brakes are the three-spot single-disc type.

During the past year, Goodyear has developed tubeless tires and tubeless tire wheels for both the main gear and nose gear. This equipment is offered as alternate equipment on 440's. Wheels are convertible and may be used for tube-type tires as well as for tubeless.

What may appear to be an unusual condition now exists with regard to the authorized wheel and brake equipment designed for the Model 440. The wheels and brakes for the 340 and 440 are completely interchangeable.

You may well ask: "If the 340 brake is good for the 440, why did you build a new brake for the 440"? The answer is simply, "The 440 brake using the new aluminum housing gives considerably better service with regard to both lining life and housing fatigue life." We will discuss the details of this a little later when we talk about service of Goodyear wheels and brakes.

Despite the basic adequacy of the magnesium housing brakes, as used on the 340, Convair Engineering feel they want to deliver the heavier brake as original equipment for 440's coming off the assembly line.

Airline operators are going both ways with regard to usage. Some are buying magnesium brakes for 440 spares and others are going along with the slight weight and price penalty for the sake of greater lining and housing service, and are thus ordering aluminum brakes.

At present, we are considering the adoption of a combination brake using the aluminum housing and the disc and lining combination as used in the magnesium brake. We at Goodyear feel that this combination will offer the greatest possible service.

Perhaps the next question to consider is "Where do we go from here"? If the 440 grows again, will airline operators be allowed to use the aluminum brakes at perhaps a higher pressure, thus coming up with an equivalent field length? Unfortunately, dynamometer tests are not conclusive in giving us the true picture.

Flight testing under the new conditions of weights and speeds is necessary. The present wheel, which by the way, is the same for the 340 and 440, may go from its present static rating of 12,800 lb to 15,000 lb. This could be tested in Akron.

The aluminum brake with the thicker disc is academically good for 3.6 million ft-lbs kinetic energy. We might think in terms of perhaps 4 million for a flight test program using the brake at 2000 psi.

If a satisfactory field length is thus established and we can make 100 stops on the dynamometer, we have a brake. If this is not possible, we must consider either a four-spot single-disc brake, a set of dual brakes perhaps of the present three-spot aluminum design using a new wheel, or go to a single or dual tri-metallic brake configuration.

Most of you are familiar with our new Goodyear tri-metallic brake through your attendance at our annual Wheel and Brake Clinic or through personal contact by our sales engineers. However, as a brief refresher: The tri-metallic is a new look to an old familiar design. You remember the original Goodyear multiple disc brake used on many older aircraft, for example the DC-4.

The most singular differences between tri-metallic and the multiple disc brakes are the disc thickness and alloys of steels which are used. The multiple disc brake used discs about 1/16 inch in thickness and the tri-metallic discs approach 1/4 inch. The alloy changes we have made in the basic materials are, of course, of a proprietary nature.

We don't feel that the tri-metallic brake is the answer to all braking problems by any means — but it's doing its part in cases of very high density brakes. We are quite sure we will be using both the single-disc spot-type brake and the tri-metallic as the exact aircraft brake requirements dictate.

Concerning service problems on our wheels and brakes, airline users are aware of the good service experienced. We are pleased to have received only two types of complaints, both on the magnesium brake used on the Model 340, and these were somewhat sporadic and scattered. Number one squawk has been the diagonal lining wear pattern causing premature removal of the lining; the other has been an occasional cylinder head backing off.

The diagonal lining wear is caused by the creep in the magnesium housing. Creep begins in the housing after some 2-1/2 to 3-1/2 years of constant airline service. The inherent characteristics of magnesium allow creep in the throat section of the housing, thus allowing the section to spread open more than normal. This, of course, causes the lining to wear diagonally and become thin on one side only.

The only possible correction was a new aluminum housing with its inherent greater creep strength. This is the reason we were pleased to bring out the new brake for the Convair 440.

The second complaint, cylinder housing backing off, has been diagnosed as actually a loss of torque due to two things: 1. It is believed that the "O" ring seal has not been lubricated before installation in its groove in the cylinder head; thus, when the head is torqued down, the "O" ring bunches up during torque application. After it relaxes and takes its natural shape, the apparent applied torque is lost. 2. We have discovered that in some cases, paint is allowed to run over the shoulder of the cylinder head. Thus a false torque is applied and later the paint relieves itself and a resultant torque loss is incurred.

ATA

SKYDROL FOR TRANSPORT AIRCRAFT

J H Langenfeld..... MONSANTO CHEMICAL CO.

Skydrol was first introduced into Convair 340 operations in 1951. During this initial introduction, a number of problems occurred with the units in which it was being used. The initial difficulties were generally mechanical and involved retention of the fluid in aircraft systems. The fluid escaped from the system primarily due to the following reasons:

1. Line failures.
2. Leakage of fittings.
3. Compressor reactor pump retainer bolt failures.
4. Leakage into air conditioning ducts.
5. Premature seal failures.

These were, of course, very important problems and as soon as the industry knew they existed it set about looking for answers to them. Now these problems have been solved through the cooperation of aircraft manufacturers, component manufacturers, and the airlines. Let's take a look at how this was accomplished.

EARLY PROBLEMS
Cause and Solution

Line failures — These were due to excessive cycling of the systems. The solution was a mechanical one and was solved by the installation of a variable-displacement pump.

Leakage at fittings — This was due to poor connection. It was solved primarily by improved techniques in working with the new fittings which were required in the higher pressure systems.

Reactor pump bolt failures — This was solved by the manufacturer of the air compressor units. AiResearch developed a new locking device for this operation.

Fluid leakage into the air conditioning ducts — this was solved by mechanical changes. These changes, made by Convair, AiResearch, and United Airlines, resulted in better performing air compressor units, regardless of the type fluid used.

Premature seal failures — Although these failures occurred on all units, they appeared to be most prominent in those compressors using Skydrol. The seals that were used in the Skydrol units were made from a new seal compound. Butyl rubber has long been used in the automotive industry for innertubes, but it had not been used previously for "O" rings and other seal materials. Early seals from this Butyl rubber needed some development before a truly satisfactory seal was available. Today, all leading seal manufacturers are making the improved seals. They are now giving comparable and, in some instances, even better service than are those used in mineral oil systems. Necessity for using more synthetics throughout the aviation industry has alerted all concerned to the needs for improved seals and sealing compounds. Today, research and development are producing better materials to meet the requirements of the industry.

It can reasonably be expected that the major improvements will be made in the materials on which the industry is focusing its development attention, so that the materials which are providing good service today will be even better.

Softening of wire covering — Since changing from vegetable oil to mineral oil almost twenty years ago, primary aircraft wire coatings consisted of neoprene-, buna- or vinyl-jacketed wiring. These materials were not compatible with turbo-engine lubricants and with other synthetic fluids, such as Skydrol. To meet this problem on Skydrol aircraft, nylon-jacketed wiring was used. This wiring is essential in jet and turbo-prop aircraft, regardless of whether or not a fire-resistant hydraulic fluid is used.

This wiring has become fairly standard in the industry today, especially since it is virtually impervious to practically all aircraft fluids and has a high degree of abrasion resistance.

Paint — The fact that Skydrol is a good paint remover on most standard surfaces is rather well known throughout the industry. In this respect, the turbine lubricants have a similar or worse effect on ordinary aircraft paint. Cat-a-lac paint, now being applied in many areas where Skydrol is not used, has made a real contribution to the jet age. A good paint such as Cat-a-lac, is needed in those areas susceptible to corrosion, regardless of the fluid used. Skydrol has forced the development of this paint. At present, a number of new and better paints is being developed to meet paint requirements of the industry.

Now let's take a look at the future. W. A. Patterson, President of United Airlines Inc., says, "Any airline executive must recognize that the jet age no longer is something you can deal with tomorrow. Whether he likes it or not, that age is here." Your beautiful Skylark 600 (Convair 880) adds materially to this fact. These new jet transports bring new concepts in aircraft manufacturing operations and maintenance. For example, the turbo-jet and turbo-prop engines will require different fuels and synthetic lubricants. These synthetic lubricants require the same compromises and adjustments that were initially experienced with Skydrol. It's really a part of growing up with a new product. Fortunately, the experience gained by the aviation industry in using Skydrol is already providing answers to the technical problems associated with the adoption of synthetic lubricants. In addition to these technical problems involved, the use of Skydrol has assisted in training personnel to meet the new techniques and procedures, which will be necessary in the future.

Although we have come a long way with the help of many in the aviation industry and those allied with it, there still remain unknown quantities associated with the operation of jet aircraft.

In summary, Skydrol has proved that it can be used successfully in all air transport hydraulic operations. In addition to providing satisfactory service, Skydrol provides the user with an added margin of safety. To this end it is necessary that all concerned with aviation development and operations work together with a free exchange of ideas on matters related to air safety. Certainly the fire-resistant fluid, as recommended by the National Fire Prevention Association and others in the industry, is a helpful step.

As each of these problems has been met and answered, it has meant a wider acceptance of Skydrol by the aviation industry, and it will be possible to move more readily into the jet air transport era.

ATA WET TANK CONVERSION

H E Hewitt.... AIRCRAFT TANK SERVICE

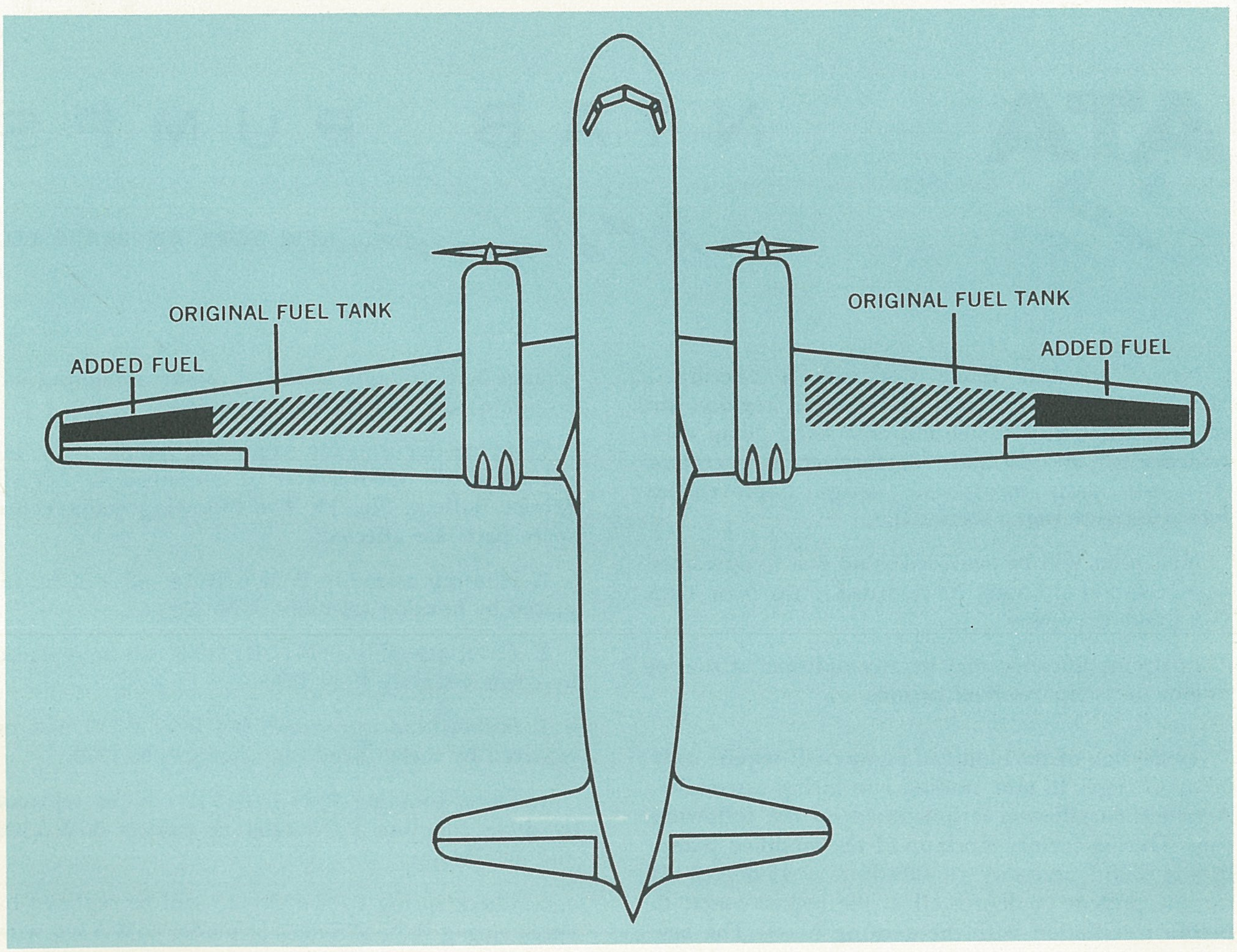
J B Littrell ...... PACIFIC AIRMOTIVE CORP.

Pacific Airmotive, in cooperation with Aircraft Tank Service, have increased cruising range of Convair 340 and 440 aircraft by increasing the capacity of the integral fuel tanks.

Fuel tank capacity has been increased on Union Oil Company's Convair 340 and on R.A.A.F.'s 440 by extending the integral tank from wing station 23 outboard to wing station 29. This additional tank area increases the capacity from 1730 gallons to 2080 gallons, plus or minus one per cent.

All fuel is carried outboard of the engine nacelles as in all standard tank configurations, thus maintaining an important design safety feature.

Neoprene faying surface seals as used on the original configuration are not used in the most outboard tank area. EC-801 overcoated with EC-776 was used to fillet all junctions of stringer-to-skin, spar rails-to-skin and to web, and spar stiffeners to spar web. All rivets in this area were also overcoated.



The following structural changes were required:

1. The new tank area between wing stations 23 and 29 necessitated heavier gage skin on the upper and lower wing surfaces.

2. The fuel-tight bulkhead at station 23 was reworked to act as a surge bulkhead to prevent fuel surges during certain flight maneuvers.

3. Existing doors and locations were maintained, but were made fuel-tight.

4. Stringer-to-bulkhead clips were added outboard of station 23 to support additional load on skin and stringers.

Other design changes include the following:

1. Relocation of the filler well to the outer tank area so as to permit maximum tank filling. (The inboard fuel filler well has been removed and a plate installed.)

2. Addition of two Minneapolis Honeywell probes to accommodate the additional fuel capacity.

3. Relocation of fuel tank vent system, outboard of expanded tank. (Inboard vent location was sealed.)

Additional oil capacity is included in the increased fuel tank capacity so as to maintain the 30 to 1 fuel and oil ratio. The auxiliary oil tank of 30-gallon capacity is located in the wing center section inboard of the nacelles. It is equipped with an immersion heater for preheating the oil; a transfer pump; a selector valve to permit transfer to either or both engines, as required; a Minneapolis Honeywell capacity probe.

Expansion of the standard oil tank configuration in the top of the main landing gear wheel well is being considered. This configuration will result in an increase of only 60 pounds to the oil tank weight.

The complete modification requires approximately three weeks, but with the experience gained on the Union Oil Company and R.A.A.F. airplanes, it is expected that future modifications can be accomplished in less time.

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ATA NYAB PUMPS

Wm M Smith...NEW YORK AIR BRAKE CO.

New York Air Brake Company is offering a retrofit-exchange program to provide replacement of 66WA300, 66WM300 and 66WA400 pump components for all 340 and 440 commercial operators. The new parts incorporate design improvements which increase pump service life.

New parts will be provided at no cost to operators, provided that old parts are returned to the New York Air Brake Company.

Pump modification may be accomplished at routine engine or pump overhaul periods.

Installation of the modified pumps will require only minor changes in tube routing and fitting assemblies. A typical installation is illustrated on the following page. During factory mock-up of the modified pump, it was found necessary to substitute a 45-degree ell for the present 90-degree ell at the bypass outlet to permit installation with the existing hoses. The new arrangement permits identical pump mounting on both left-hand and right-hand engines.

Complete information regarding pump parts involved in the modification is contained in NYAB Service Bulletin No. 39. The following maintenance spare parts are affected:

1. Housing assembly P/N 67B1146-6S will be replaced by housing assembly P/N 2243-6S.

2. Cover assembly P/N 67B1249-6 will be replaced by cover assembly P/N 1695-6.

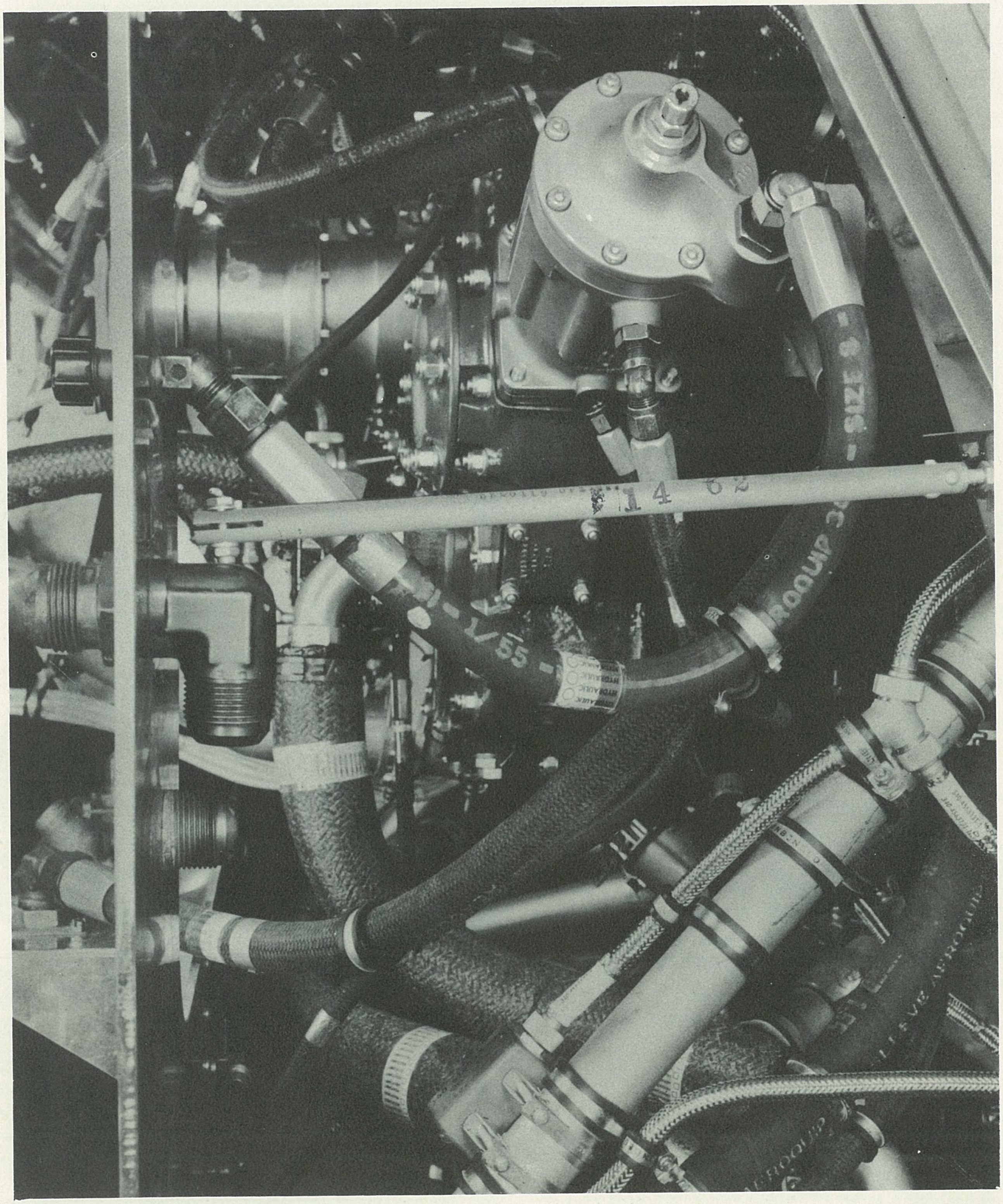
3. Socket head cap screws (8) P/N P-237 will be replaced by socket head cap screws P/N 1779.

4. Drive coupling P/N 67B1501 will be replaced by drive coupling P/N 2208 in models 66WA300 and 66WM300.

5. Check spring P/N 67A1123 will be replaced by check spring P/N 67A1457 in model 66WA300 with

serial prefix designations A, B, C, AO; and in model 66WM300 with serial prefix designations A and AO. Any pumps in either model with a prefix designation of BO or later are unaffected by this change. The 66WA400 pumps do not require this spring conversion.

6. Drive coupling P/N 67B1503 will be replaced by drive coupling P/N 2349 in model 66WA400.



CONVAIR Traveler

VOL. VIII NO. 5 SEPTEMBER 1956

CONVAIR *Traveler*

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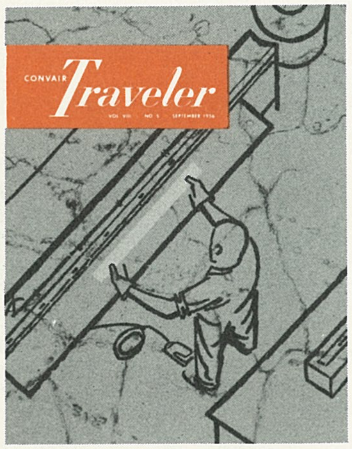
FOREWORD

Today, aircraft high-speed and low-weight requirements have created a demand for a new metal — a non-corrosive metal with a high weight-to-strength ratio — a metal capable of withstanding the extremes of hot and cold temperatures — a metal that is easy to find and inexpensive to produce.

Most metallurgists agree that titanium fills all the requirements for this new substance with one exception . . . it is in the precious metal class because of its high mining and manufacturing costs. It is, however, strong, light, non-corrosive, and abundant. It is the fourth most plentiful mineral on the earth's surface and, despite its price, is being widely used on military aircraft and guided missiles.

Titanium is also finding an ever-increasing use in commercial aircraft power plants where its high cost is offset by increased fire protection and low weight and, even though thermal barriers and supersonic speeds are not among the immediate worries of commercial airline operators, more and more titanium parts will be used as new design features generate problems which may be solved only by this new metal.

ON THE COVER



Titanium, as it appears to the brake operator and to the metallurgist, is portrayed on our cover this month by artist Dick Henderson. The map-like pattern in the background is a piece of titanium which has been magnified 500 times.

C O N V A I R
A DIVISION OF GENERAL DYNAMICS CORPORATION
(SAN DIEGO)

A digest of Convair-Liner operation and service published monthly by the Service Publications Section of Convair in the interest of Convair-Liner operators. Communications should be addressed to Chief of Service, Convair, San Diego 12, Calif.

titanium

When titanium was introduced to the aircraft industry less than a decade ago, many optimistic authorities hailed it as a "wonder metal" which would solve all of the problems of the industry.

They predicted that it would be strong enough to contain the explosive thrust of a jet engine, light enough to be used as a major structural metal, and impervious to most corrosive media.

Later, when early enthusiasm subsided, more conservative metallurgists confirmed that titanium, despite a number of shortcomings, did possess a high strength-weight ratio, and it has since proved its ability to withstand corrosive attack during extensive corrosion tests in Government and private laboratories.

Titanium is classified as a light metal — it is only 56 per cent as heavy as alloy steel, yet it is capable of being heat-treated to strength levels of 180,000 to 200,000 psi. Some alloys maintain this high strength-weight ratio to temperatures of 600° to 800°F. The ability of titanium to serve efficiently in the intermediate temperature range has made it particularly valuable as an aircraft structural material.

Almost all of the titanium produced today goes into the primary structure, bulkheads, skins, and power plants of military jet aircraft and, as new alloys are developed, designers will find many additional uses for the metal. Some authorities estimate that future aircraft models will have as much as 60 per cent titanium in their structure.

Applications in the commercial transport field have been slow, primarily because the armed forces have, until recently, absorbed the entire production; however, as production volume increases — and it is increasing rapidly — lightweight titanium will replace many of the corrosion-resistant steel parts on commercial transports. Many new commercial transport specifications, including the Convair "880," call for titanium in power plant areas.

A secondary obstacle to the widespread use of the new metal is its price. The initial cost of titanium is high, but in some industrial applications it has paid for itself many times over by increasing service life of equipment or by increasing pay load.

The DuPont Chemical Company reported that corrosive media formerly ate through corrosion-resistant steel tubing in six months but, since titanium tubing was substituted two years ago, no further signs of attack have been experienced.

Many aircraft companies have found that, although titanium fasteners cost more than four times as much as steel counterparts, they save many times their cost in overall weight. One company recently estimated that the substitution of titanium bolts, screws, and rivets for steel in a commercial transport would save 500 pounds of pay load.

Even if the cost of titanium remains at its present high level, there will still be many industrial uses for it. But, as mining and production methods improve and volume increases, the price of the metal will be lowered appreciably. It is however, highly doubtful that the price of titanium will equal that of steel within the foreseeable future, because the methods used for extracting the metal from raw ore are far more complicated and expensive.

MINING AND PRODUCTION METHODS

Titanium, in its natural state, is found everywhere. Rutile sand and ilmenite rock, the richest titanium bearing minerals, are scattered abundantly over the earth. In fact, they are scattered a trifle too abundantly for economical mining. The metal is so thinly distributed that tons of worthless sand must be processed to secure a small quantity of pure ore. Even though an area in Eastern Quebec contains enough raw material to manufacture over 2000 solid titanium battleships, the cost of separating pure ore from sand makes the prospect of titanium battleships extremely remote.

Metallurgists have been attempting to purify titanium since the metal was discovered in the Eighteenth Century, but their efforts have been thwarted by one troublesome characteristic — molten titanium absorbs gases from the atmosphere in wholesale quantities. When early scientists attempted to refine it by melting the ore in an open pot, which was the

only method they knew, nitrogen, carbon, and oxygen from the air contaminated the metal, and the puzzled researchers were left with a lump of useless, brittle slag.

In 1932, Dr. Wilhelm Kroll, a metal scientist from Luxemburg, developed the method which is currently being used. In this method, raw ore is processed under a protective blanket of inert gas, which prevents any contamination during production.

Extraction of pure titanium from ore is a complicated, two-stage operation. In the first stage, titanium dioxide is obtained by smelting raw ore to secure a slag of high titanium content. The slag is then mixed with carbon and heated in a stream of chlorine which produces titanium tetrachloride. The tetrachloride must then be fed into a cylindrical reactor to which magnesium chloride has been added. After magnesium chloride is separated from the mixture, the sponge-like substance which remains is 99.5 per cent pure titanium.

After the sponge is manufactured, it must still be crushed, sized, and arc-melted under inert gas or in a vacuum. Then it is rolled into sheets or bars. Approximately two pounds of sponge are required to make one pound of titanium stock.

High scrap loss is another factor which increases the cost of titanium. Until recently, there was no way to reclaim the valuable scrap which accumulated during production. To ease this situation, and to prevent the waste of tons of usable scrap, the Defense Service Administration recently assigned a high priority to the development of scrap reclamation methods. The Government order also classified titanium scrap as critical material and it is being stockpiled while reclamation methods are being perfected.

PROPERTIES. One of the early objections to titanium was its apparent lack of uniformity. Shop personnel could not predict the behavior of different brands of titanium because the products of various manufacturers differed widely. This variance, which was caused by slight differences in chemical content and processing, resulted in many cracked parts and frayed tempers during production.

The problem of uniformity has been partially alleviated by a set of standards recently established by the Society of Automotive Engineers. (See Table I.) Titanium is now divided into classes according to yield strength and tensile strength, with minimum allowable bend radius as an additional criterion.

SAE-AMS specifications will replace confusing standards established by numerous individual producers and manufacturers, and will provide a basis for a uniform, industry-wide classifications system.

The most widely used grades of commercially pure titanium have a minimum yield strength of 70,000 and a maximum tensile strength of 80,000 psi. Variations in elongation range from 10 to 20 per cent.

If the properties of individual grades are carefully considered when shop procedures and machine settings are established, successful fabrication of titanium will present no more of a problem than does successful fabrication of magnesium.

At medium and moderately elevated temperatures, an oxide skin forms on the surface of the metal to protect it from further oxidation; however, at approximately 1000°F, the metal begins to absorb its own skin and, above 1400°F, the unprotected surface begins to absorb weakening elements from the air. Tests indicate that some titanium alloys can be exposed for a maximum of one-half hour to temperatures of 1500°F but, if exposure is prolonged, the metal rapidly deteriorates.

Titanium loses little of its strength as the temperature drops. This ability of titanium to retain strength in the intermediate temperature field, has made it a valuable asset to aircraft and missile designers and it will also be valuable in increasing commercial transport service life through a wide range of operating conditions.

Intensive corrosion tests by government and private laboratories reveal that there are very few substances which will damage titanium. Because the resistance of the metal to corrosion is caused by a thin surface layer of oxide, metallurgists at first felt that acids would be able to break through the protective film and attack the surface; however, during corrosion tests, titanium strongly resisted nitric acid, wet chlorine gas, cupric and ferric chlorides, and most other damaging substances.

Marine atmosphere and sea water do not affect its shiny surface. A piece of titanium tubing could be dropped in the ocean in 1956, and then, in the year 2206, it could be recovered and used. In many new aircraft designs, titanium fire extinguishers, ducting, and anti-icing systems have solved a long-standing corrosion problem.

Titanium, however, is not impervious to all substances. Red fuming nitric acid may cause a violent explosion if it is handled carelessly with titanium; dry chlorine gas will ignite powdered titanium; hydrochloric acid attack increases as temperatures rise; and it is vulnerable to hot oxalic, trichlorocetic acids, and boiling concentrated formic acid solutions.

The ability of metals to withstand galvanic corrosion (the chemical action of metals to one another) is easily tested by suspending dissimilar metals together in a corrosive medium, the more "noble" metal showing less damage after suspension for a given period of time. When titanium was tested with corrosion-resistant steel, which is one of the most noble aircraft materials, neither metal revealed measurable corrosion.

TABLE I

TENSILE AND YIELD STRENGTHS

AMS SPECIFICATIONS

	NUMBER	COMPOSITION (%)					TENSILE STRENGTH	YIELD* STRENGTH	ELONGATION**
		Titanium	Manganese	Carbon	Hydrogen	Other	(PSI)	(PSI)	(%)
Sheet — Strip	4900A	99.18		.20	.015	.6	65,000 min	55,000 to 80,000	18
Sheet — Strip	4901B	98.98		.20	.015	.8	80,000 min	70,000 to 95,000	15
Sheet — Strip	4908	91.0	7.0-9.0	.20		.8	120,000 min	110,000 min	10
Bars Forgings	4921	99.0		.20		.8	80,000 min	70,000 min	15

*Yield strength at 0.2% offset or at the following values in two inches extension under load (E = 15,500,000) psi.

4900A = .0111 inch
4901B = .0130 inch
4908 = .0182 inch
4921 = .0130 inch

**Minimum percentage of two-inch sections except for 4921 which is the percentage in 4D (Sections under three inches).

Minimum Allowable Bend Radius
Bend Factors

Specification	Under .070	.070 to .187, incl
4900A	4	5
4901B	5	6
4908	6	7

Material shall withstand bending (without cracking) at room temperatures through an angle of 105° around a diameter equal to the bend factor times the nominal thickness of the material, with axes of bends perpendicular and parallel to the direction of rolling.

MANUFACTURING TECHNIQUES

Every day, titanium sheets are being trimmed, punched, stretched, rolled, and pressed into a variety of intricate shapes. This work is being accomplished in fabrication shops with no special equipment other than that used for working steel. Personnel handling titanium are usually skilled metal workers with a high degree of training and experience, but it should be noted that even skilled workers have occasional difficulties until they get the "feel" of the metal.

Shop mechanics should, first of all, learn how to recognize the metal. The finish of titanium resembles corrosion-resistant steel in appearance, but it doesn't always react in the same manner. When titanium is brushed against a grinding wheel, it emits a shower of distinctive white bursting sparks. This may be used as a test to determine whether unmarked parts are titanium or corrosion-resistant steel. If, however, a grinding wheel is not available, an edge of the part may be rubbed on a piece of glass. Titanium leaves a dark, pencil-like smudge.

CUTTING OPERATIONS. Preparing titanium alloy for forming presents no particular problems. It may be sheared, sawed, nibbled, or blanked on standard equipment rated for one-quarter or one-half hard steel.

Material up to .187-inch thick may be cut on a standard, flat-bed power shear, rated for 7-0 gage mild steel. If the blade is sharp, and a close tolerance between blade and bed is maintained, edges will be clean and sharp without cracks and with a minimum burr. A good rule-of-thumb is to set the blades to clear 10 per cent of the material thickness. The reaction of .187-inch titanium to shear operations is similar to one-quarter hard steel of comparable gage; the same amount of power is required to operate the shear.

Titanium may be successfully cut in gages from .016 to .080-inch on most types of rotary shears and nibblers; however, gages heavier than .080-inch should be cut by square shears, punch press, or saw in order to produce a straight, even cut. Nibblers and rotary shears tend to leave an irregular edge which requires an additional smoothing operation.

The Ryan Aeronautical Company recently conducted a series of tests to establish standard procedures for sawing titanium. A number 36 DoAll bandsaw with a raker-set, 1/4-inch blade, was used. In order to find the exact speed and tooth spacing for cutting various gages of titanium, blades with 4, 6, 10, 14, and 24 teeth per inch were tested, and cutting speed was increased from 200 to 1000 feet per minute in 100-fpm increments. Several rates of feed were also tested.

The tests revealed that blades with 10 teeth per inch, which were operated at 700 feet per minute, produced the most satisfactory results. When optimum feeds were limited to five inches per minute for .125-inch material, and 15 inches per minute for .070-inch stock, there was no chatter or tooth-loading. Proportionately higher speeds were effective on lighter gages of material.

Friction sawing may be used on titanium just as it is used on C. Res steel. Best results may be obtained with a used, 1/4-inch blade which has been discarded from a conventional sawing operation; however, in this type of cutting, the following difficulties have been experienced:

1. A heavy burr is formed, proportional to the thickness of the material gage.
2. If the feed is stopped, it is difficult to restart, due to the hardness of the material.
3. The operator must be prepared for sudden increases in cutting rate, which always occur after the initial slow rate of starting. *Best friction sawing results are obtained by maintaining an uninterrupted cut.*

Punch-press blanking operations are similar to those of steel; however, the force that is required to blank titanium is greater, and the life of the blanking die may be shorter. Titanium blanking dies should be kept in top condition to prevent excessive burr or cracking.

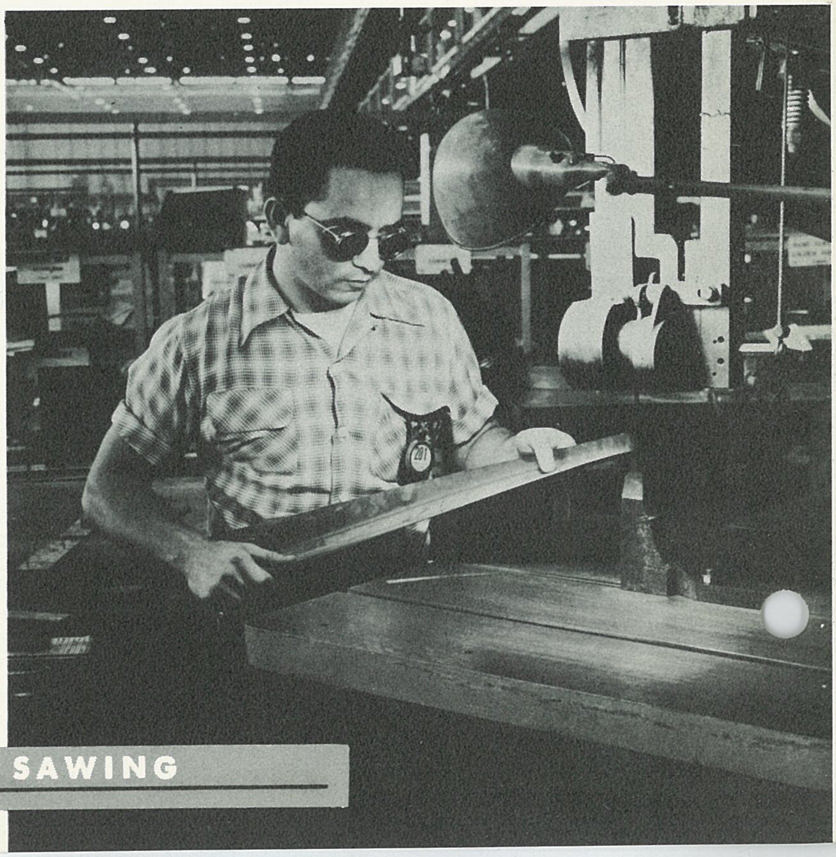
Blanking dies of various sizes and configurations have been used on gages of titanium sheet ranging from .016 to .125 inch. If machinery and tools are in good shape, holes, slots, and flat pattern developments may be produced with a minimum burr which is no greater than that found in most common corrosion-resistant steels.

Production tools which are used for titanium should be heavily constructed of the best steel available in order to counteract the heavy force required to cut the metal.

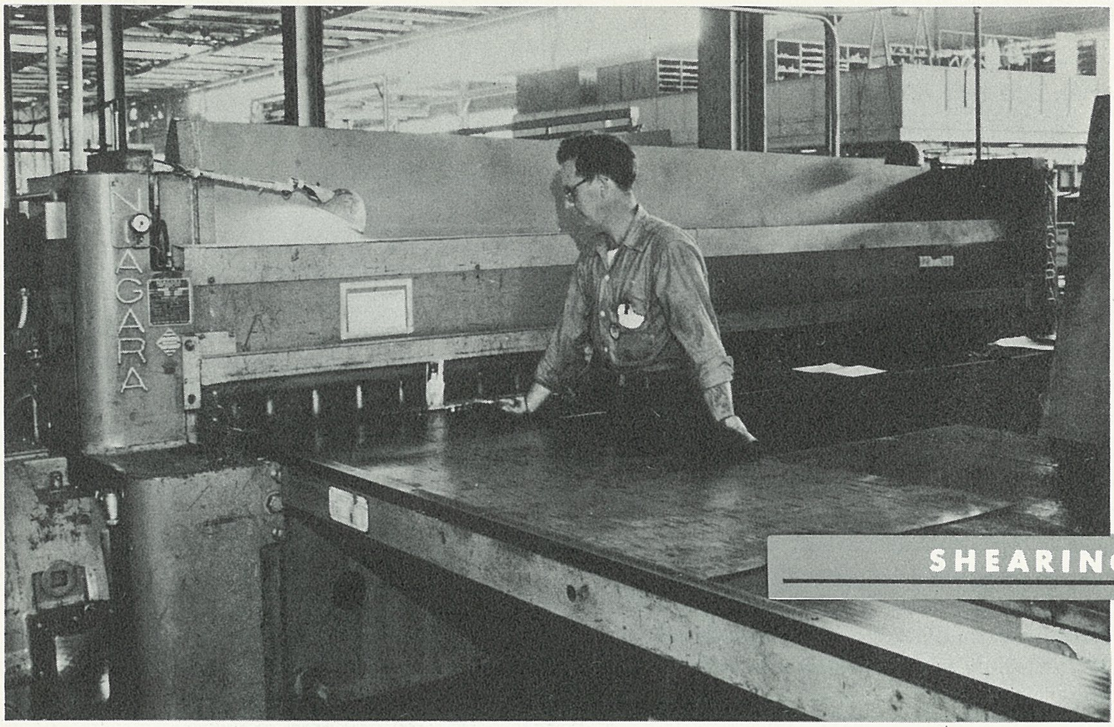
MACHINING. Convair's Manufacturing Research and Development Department recently conducted a series of tests to determine the most effective feeds and speeds for various drill sizes. A three-foot radial arm drill press with a speed range of 135 rpm to 2100 rpm and a feed of .004 inch to .025 inch per revolution was used in one series of tests.

The various drill sizes were tested on a one-half-inch plate of Ti 150A and four laminated strips of RC130A. Pemaco 200, an oil-emulsion water-based coolant was used during the tests; however, no attempt was made to evaluate the efficiency of the coolant.

The first tests indicated that a heavy-duty cobalt high-speed steel drill performed satisfactorily at



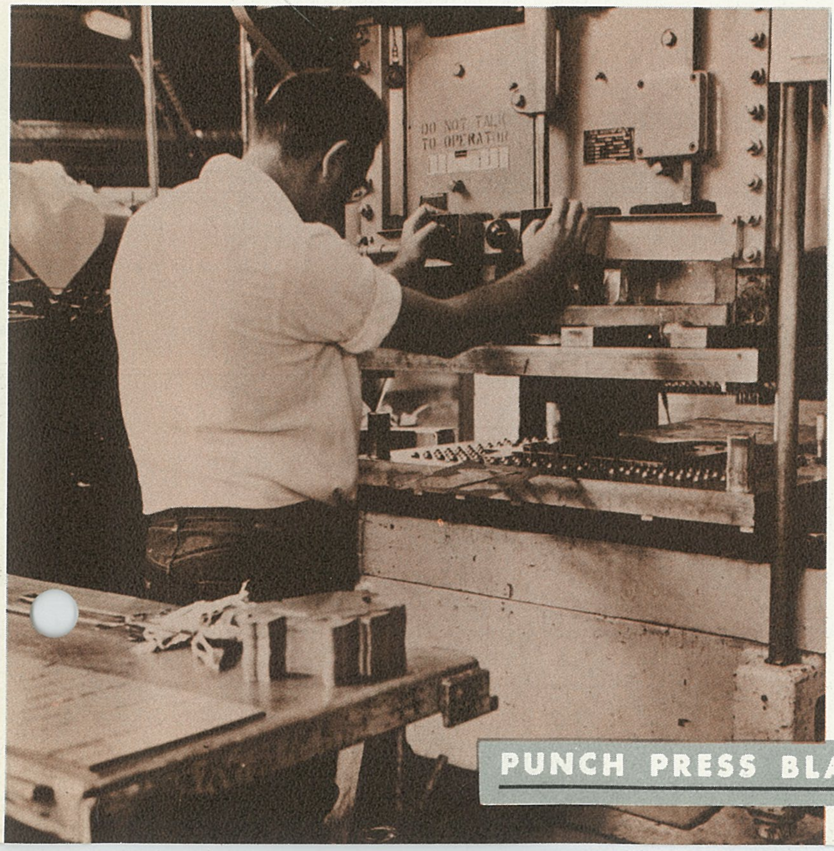
SAWING



SHEARING

speeds of 50 feet per minute and feeds of .001 inch per revolution.

Two $\frac{1}{8}$-inch drills, one with a 135° point angle, and the other with an angle of 118°, were used to drill 20 holes in the metal. Both drills performed their function with equal efficiency and neither showed measurable wear.



PUNCH PRESS BLANKING

In order to find the feed and speed at which minimum drill wear and maximum efficiency were realized, many combinations of drill sizes and materials were tested. Standard high-speed-steel twist drills pierced the metal without difficulty, and Cobalt high-speed-steel drills also performed satisfactorily at higher rates of speed.

Aluminum oxide or silicon carbide grinding wheels of coarse grain (60) and medium hardness may be used on titanium during low-speed (1600 feet per minute or less) operations. A cooling bath of water-soluble, sodium nitrate amine type lubricant will greatly increase the effectivity of grinding operations.

During any grinding or cutting operation which results in titanium chips or dust, fire extinguishing equipment should be readily available. The generous use of lubricants will, however, minimize the danger of fire.

FORMING. Titanium alloy has forming characteristics comparable to those of $\frac{1}{2}$-hard corrosion-resistant steel, and the commercially-pure grades may usually be formed as easily as $\frac{1}{4}$-hard corrosion-resistant steel.

The following major factors influence the formability of titanium alloy:

1. Yield strength to ultimate tensile strength ratio
2. Low ductility at room temperature
3. Sensitivity to rate of strain

4. Directional strain
5. Low ratio of uniform strain to necking strain (approximately half that of corrosion-resistant steel)
6. Notch sensitivity
7. Resistance to shrinking.

Good quality tools, high pressure, and slow action, and the careful application of heat will eliminate many forming difficulties; however, there are still problems which may only be solved by the development of new alloys, and the improvement of stock in current use.

Heat, applied cautiously before and during the forming process, will relieve some of the stresses imposed by cold working, and will improve ductility. Experiments at Convair indicate that the best temperature range, for both commercially pure and alloy titanium, is between 900° and 1000°F ±50°; for less severe forming, a temperature of 500°F is satisfactory. From 600° to 800°F there is no measurable improvement in formability.

Uniform heating is as important as a particular temperature level; therefore, heating by hand torch, which may cause uneven distribution, is not recommended. Conduction heating, in which a heated die transmits heat to the blank by contact, is one of the most effective methods. The primary advantage of this method is that only the 'working' area of the blank is heated, since only that area comes into contact with the die.

Blanks may also be heated by electrical resistance, or in an oven, but no matter which method is used, it is important to maintain temperature checks to prevent contamination of the metal by overheating.

Experiments on hydropress forming indicate that some thin gage parts may be formed satisfactorily at room temperatures, while others may rupture. In most cases, ruptures in the material were parallel to the rolling direction. Parts which cannot be formed at room temperature on a hydropress may usually be successfully produced after both form block and/or blank have been heated.

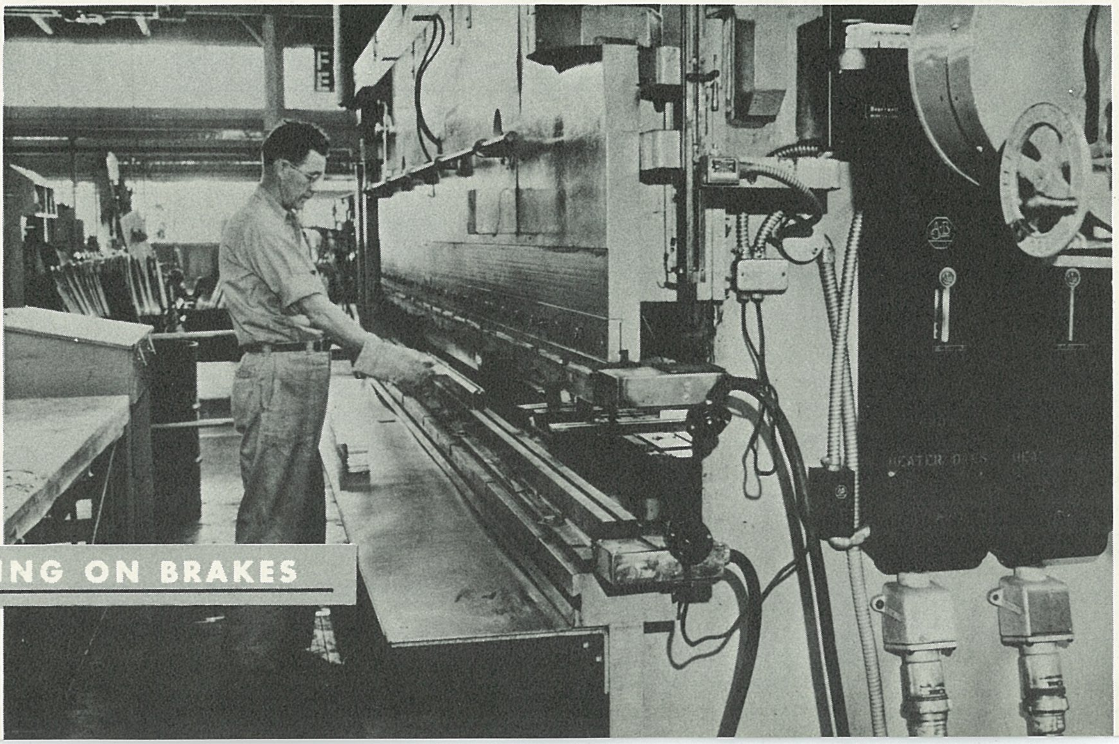
During hydropress experiments, forming blocks were heated to 900°F, the cold blank was placed on the block and heated with a torch, then, the blank and die were covered with asbestos insulating fiber; a hard rubber pad was placed over the asbestos, and the part was formed in the hydropress.

Good forming results have been obtained by making the draw in three or four successive stages, and by lubricating the blank. If draw radii is sufficiently large, the metal will flow smoothly without galling or seizing.

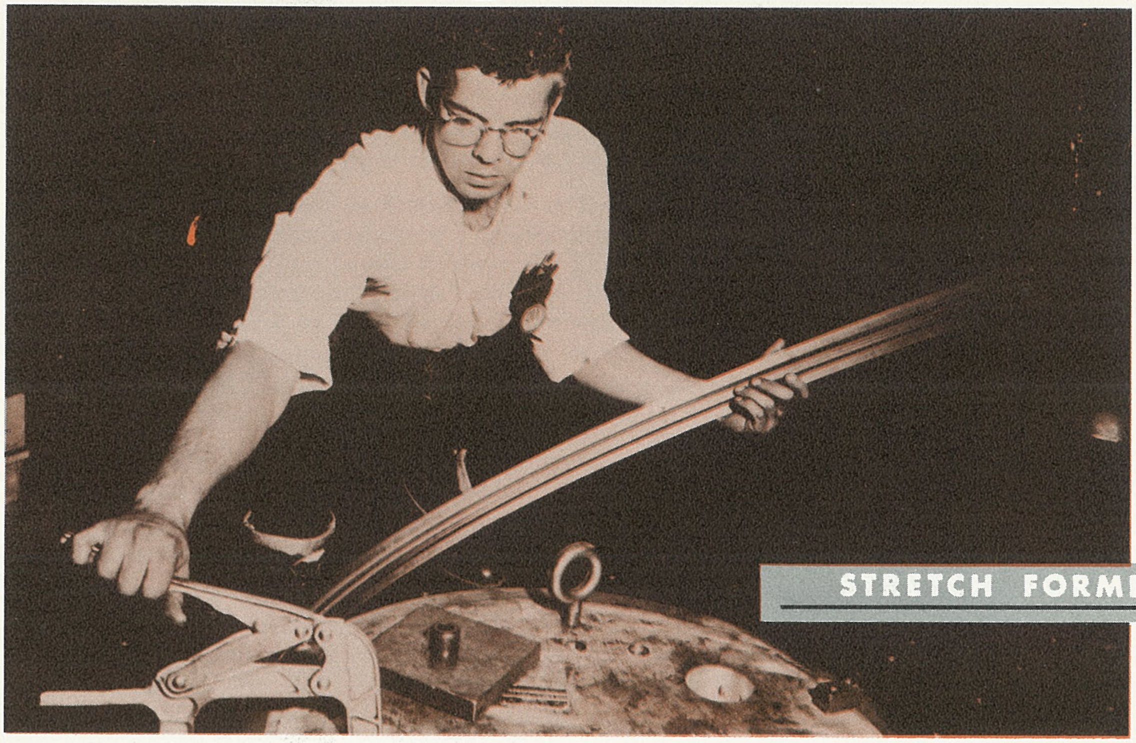
To test the reaction of titanium to low temperatures, blanks were precooled to —40°F by dry ice. In contrast to the successful forming accomplished at room temperature in four interrupted stages, the precooled blank fractured during the third stage, while a second precooled blank formed satisfactorily when the draw was accomplished in a single stage.

Forming a titanium part by impact requires more operations than forming a comparable steel part; however, drop hammers are also used to form titanium.

As in the hydropress operation, simple contours in softer alloys may be impact-formed at room temperature, and more complicated contours in harder grades may be heated for greater ductility. In impact operations, however, it is not advisable to heat the die, as it may become warped and damage the part.



BENDING ON BRAKES



STRETCH FORMING

Hard-faced kirksite dies and lead punches may be used for impact forming, but to prevent lead punches from melting and contaminating hot titanium blanks, it is advisable to add a protective mild steel jacket to the punch before it is used. A coating of dry film lubricant, graphite, or molysulphide powder may be used in hot forming to reduce galling and seizing.

Bending titanium sheet on brakes is another effective forming method; however, in this method, as in all the others, it is well to remember that titanium has individual characteristics which affect its formability.

Many titanium specifications involve a bend test which has caused considerable confusion among users of the metal. The test itself is a guided bend in which the sample is forced into a female die with guided dies having varied radii. For a given bend,

14 62

STRETCH FORMING

105° for example, the smaller the bend radius, the more ductile the metal. The radius is usually designated in terms of the thickness of the material, i.e., 1T, 5T, 2T, etc. The nonferrous metal industry has generally used radius of bend for this designation, but the steel industry often uses diameter. Titanium bend values are sometimes indicated with no reference to radius or diameter; however, commercially-pure titanium up to .095 inch thick will successfully bend 180°, parallel to the rolling direction, on a diameter of 1T (a radius of ½T).

When the bend is made perpendicular to the rolling direction, values are slightly lower, being a diameter of 1½T for the same material. The high-strength alloy grades are less ductile, although material available in the 150,000-psi tensile range will bend 105° on a diameter of 4T, or a radius of 2T, in thicknesses .095 inch or lighter. For cold forming, a safe minimum bend radius is 3T for gages up to .070 inch and 3½T for heavier gages. In the aircraft industry, bend radii of 3 to 5T have been maintained to compensate for possible variations in material formability.

The springback of titanium at room temperature ranges from five to ten degrees, which is slightly higher than that of corrosion-resistant steel. To reduce the bending radius, the die may be heated to 600°F or above before bending.

One of the problems encountered in forming sheet is the lack of uniformity between the top and bottom of a single sheet. The material will sometimes withstand bends from one side better than from another, due to the fact that one side may have absorbed impurities during the rolling operation.

To overcome this problem, bend properties may be improved by vapor blasting, which removes surface imperfections and, at the same time, increases the fatigue life of the material. Pickling in a mixture of nitric acid and hydrofluoric acid may also be used to remove the thin surface layer; however, caution should be exercised if this method is used, since hydrofluoric acid may cause the material to become brittle.

Lack of uniformity, formerly a major deterrent to the widespread use of titanium, is no longer a critical problem — even though it still occurs occasionally. As titanium producers manufacture more uniform ingots, and rolling experience increases, the problem will be eased. Until it is completely resolved, however, it will be necessary to allow for slight deviations in quality when manufacturing titanium parts.

Titanium shapes, such as zee sections, can be roll-formed if they are heated; however, stretch-forming is preferred, since it reduces compression flange wrinkles.

In forming zee sections, the axis of the bend in the material is made parallel to the direction of rolling, and provisions are made for exaggerated springback, which often occurs in cold-worked titanium because of its rapid rate of work hardening.

If parts are formed at stress-relieving temperatures, heat treatment after forming will reduce springback, hold tolerance of close-fitting parts, and reduce the loss of compressive yield strength. Cold stretching may cause a loss of 15 to 30 per cent in compression yield strength (Bauschinger Effect); however, a suitable heat-treat operation will restore 90 per cent of this loss.

Titanium stretches easily, but it is hard to shrink; so, to compensate for this characteristic and to eliminate buckling in the reduced area, hot forming, which allows shrinking and increased stretching, is advisable.

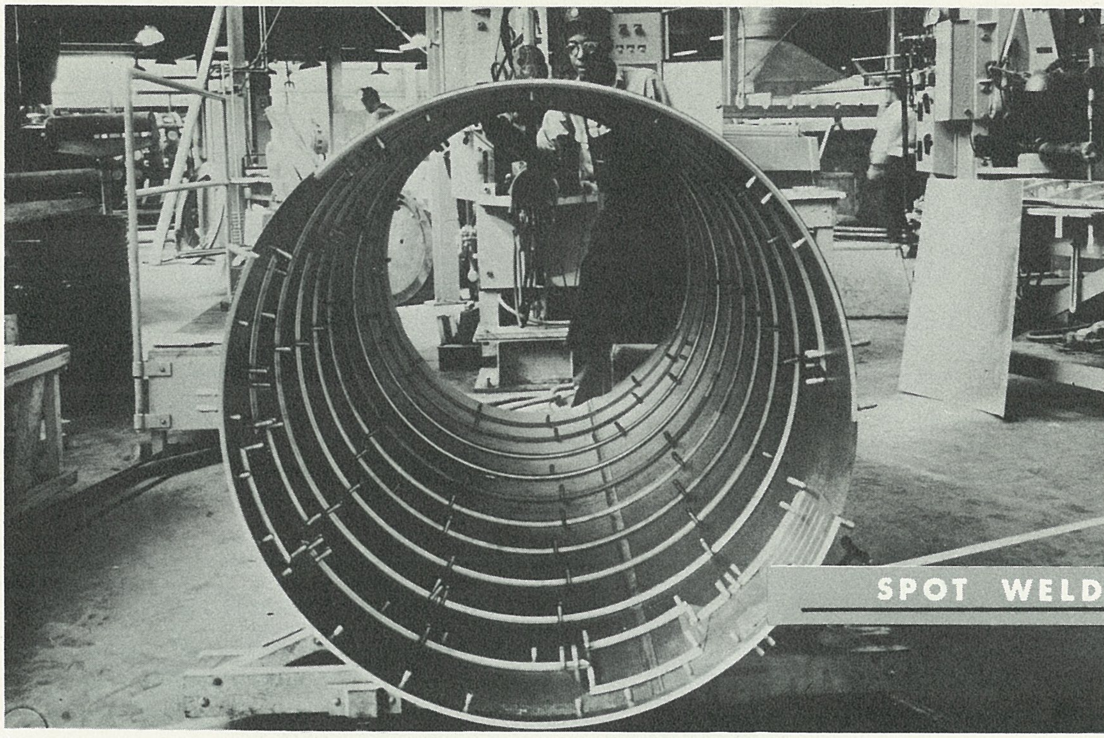
When stretch-forming titanium, a small compression bend produces the best results. This condition may be achieved by applying sufficient stretch to the outside flange to move the inside flange closer to the neutral axis. The chief limitation in applying pressure to the outside flange is the width of the web. If it is too wide, it may cause the material to rupture.

Titanium may be dimpled in gages up to .065 inch on Ram Coin or equivalent dimpling machines. Best results are obtained when dies are heated to 750°F and permitted to rest against the part prior to dimpling. A dwell time of two seconds, in addition to the normal time delay while the machine is building up pressure, will allow sufficient heat to be transmitted to the blank. After dimpling, a close inspection for fine irregular, circumferential cracks is imperative.

WELDING AND BRAZING. Unalloyed titanium and some alloys can be joined by resistance welding or by inert gas shield arc welding. Oxyacetylene and metal arc welding with coated electrodes are not used because of the danger of air contamination. Inert gas-arc welding is the only satisfactory method of shielding the welding zone from contaminating gases in the air; this method also permits the welding pool to be developed with or without a filler rod. Special nozzles or jigs direct the flow of gas to the welding area.

Spot welding can be accomplished by standard equipment and procedures without danger of contamination.

Unalloyed titanium can be brazed to itself by electrical resistance heating, or by heating in an inert gas atmosphere furnace. A commercial fluoride flux, which has recently been developed, is extremely effective when it is used with low melting-point, silver-brazing alloys. It protects the surface from contamination and assists the flow of brazing com-

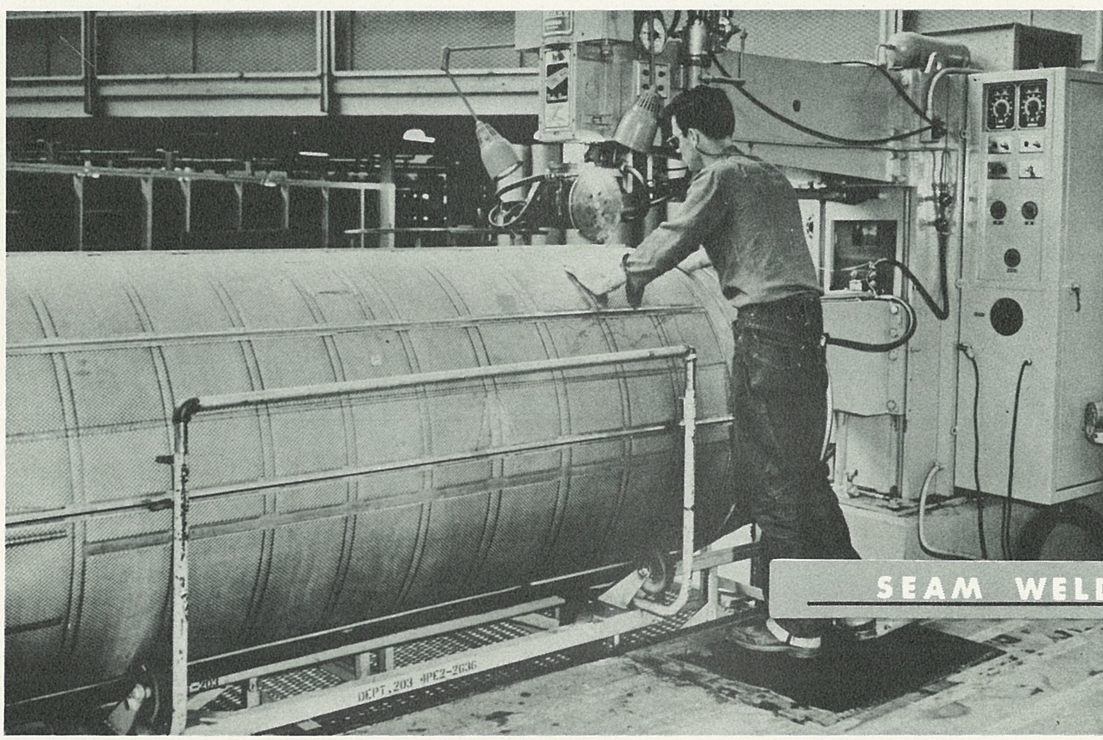


SPOT WELDING

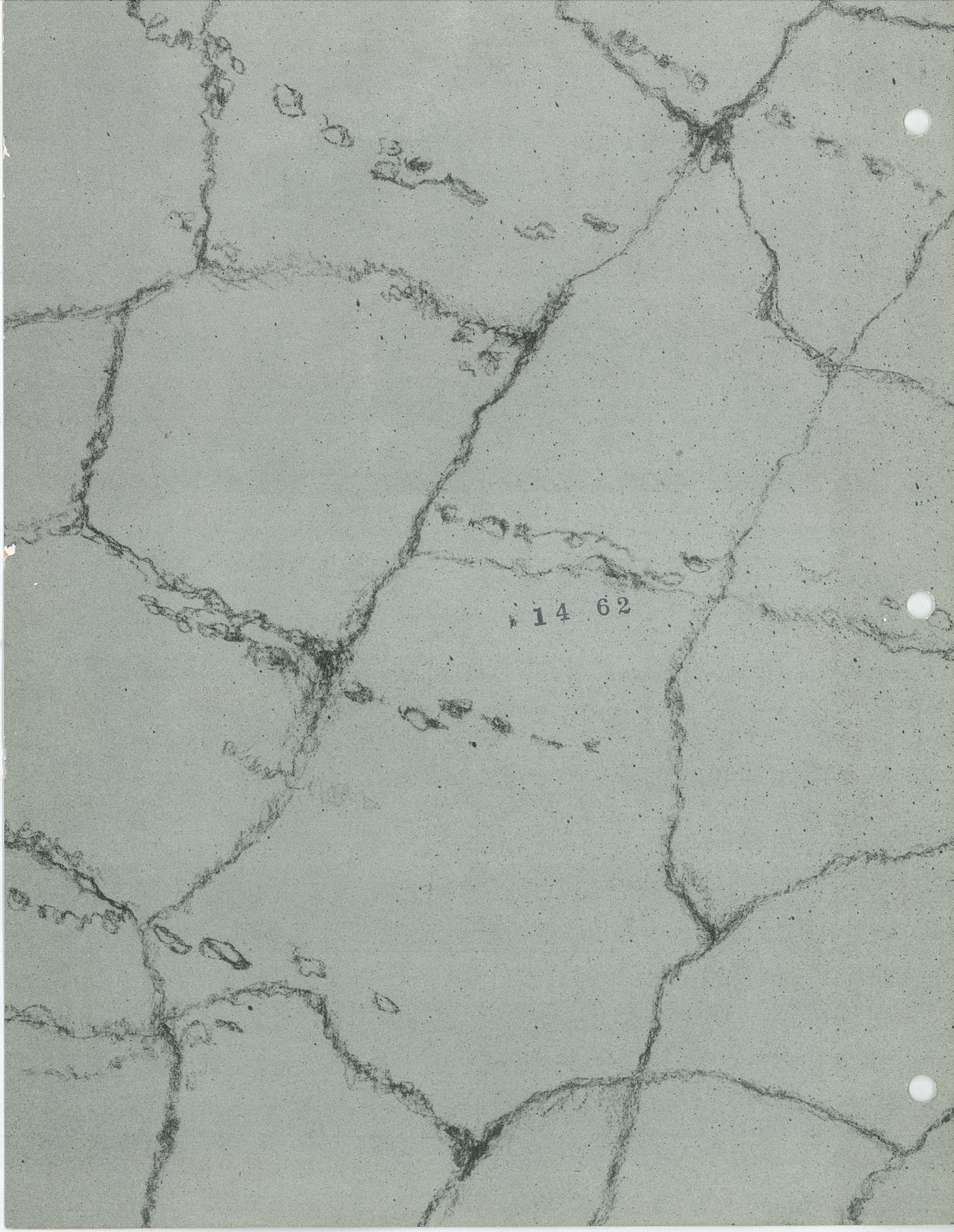
pounds by removing metallic film.

When brazing titanium, a generous application of flux, above and below the joint, will reduce the danger of contamination; however, as an additional precaution, it is important to complete the joint as rapidly as possible after solder has started to flow.

If surface scale develops during fabrication, it may usually be removed by pickling. A 47 per cent solution of nitric acid, combined with two per cent hydrofluoric acid will remove most light scale without pitting the material; however, heavy scale formations, which occur at temperatures above 1300°F, are removed most effectively by sand blasting, or by a molten sodium hydroxide salt bath which has been heated to 700° to 850°F. Molten caustic soda is not recommended for removing scale unless inhibitants are added to the mixture to prevent violent reaction.



SEAM WELDING



CONVAIR *Traveler*

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VOL. VIII NO. 6 OCTOBER 1956

J. M. Elliott

CONVAIR *Traveler*

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FOREWORD

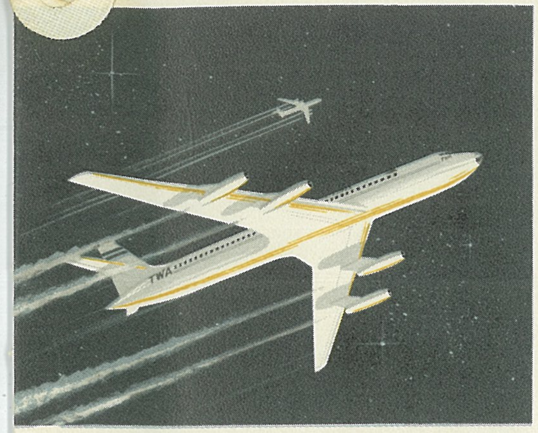
Convair proudly presents to the jet-age family, the Convair "880." It is believed that this airplane will supplement and complement the long-range commercial jets already moving toward production.

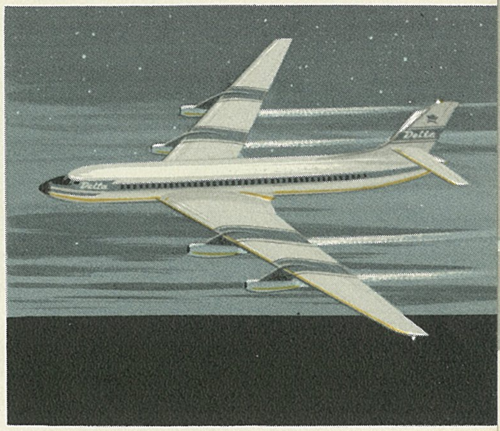
There has been much speculation in the past few years as to whether an all-jet transport could be made economically feasible for medium- and short-stage operations. The problems involved in the design of such an aircraft, both aerodynamic and economical, have admittedly been difficult. However, the problems are now past. On the following pages, Convair describes its answer to the speculation with an affirmative YES: the Convair "880."

ON THE COVER

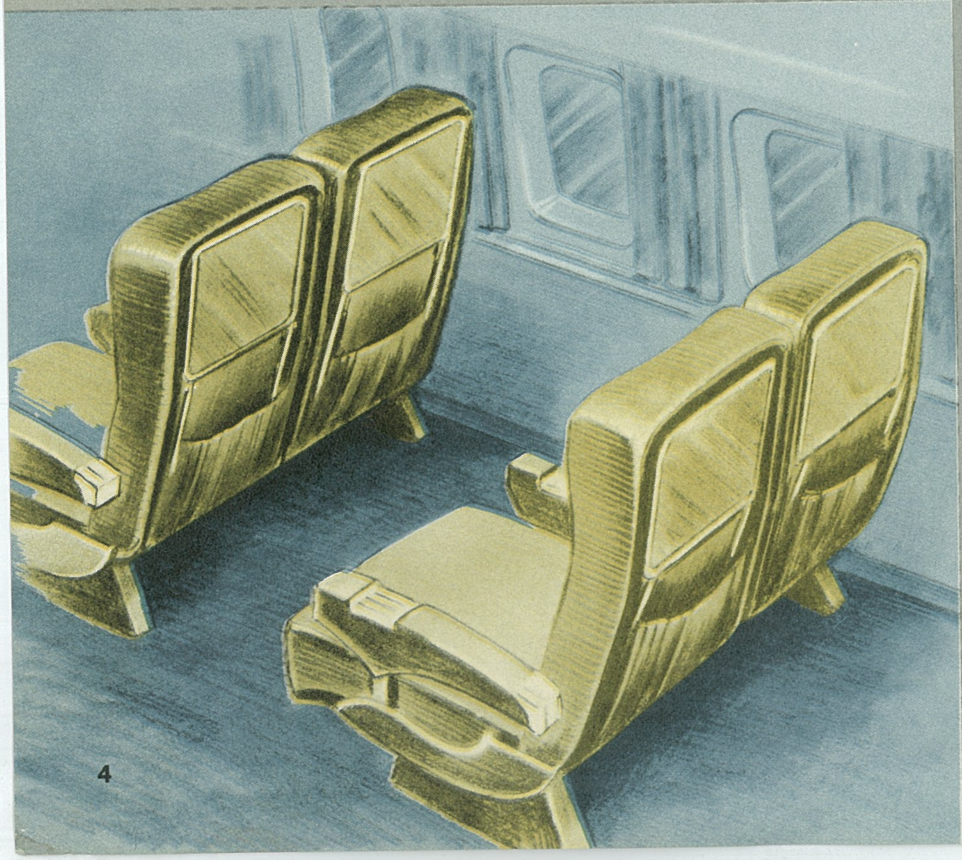
Artist Dick Henderson portrays Convair's contribution to the medium-range transport field — the Convair "880." Hundreds of miles an hour faster than turboprops, yet able to land and take off from modest runways, the "880" represents the ideal mating of airframe and engine (G-E CJ-805) for maximum speed and economy.

A digest of Convair-Liner operation and service published monthly by the Service Publications Section of Convair in the interest of Convair-Liner operators. Communications should be addressed to Chief of Service, Convair, San Diego 12, Calif.





*Nearsonic speed plus safety and economy will be wrapped into one streamlined package when Convair's latest design, the "880," rolls off the production line. *Plans for the new swept-wing luxury liner, which will be the fastest commercial transport in the world, were initiated by Trans World Airlines and Delta Airlines, whose long-range planners have been searching for a new aircraft to complete a fleet modernization program by 1960. The aircraft had to be fast to maintain America's air superiority; it had to be economical to keep airline travel competitive; and it had to be versatile to be used alternately for medium- and short-range flights. Many new designs were studied by the airline engineers before they found the exact model to fit their needs. Their search ended with the Convair "880." Here was a sleek aerodynamic design, powered by four General Electric CJ-805 turbojets — commercial versions of the J79. *Passengers will ride in easy-chair luxury while power plant noise is reduced to a subdued murmur inside the cabin. The first-class version of the Convair "880" will carry 80 passengers in luxurious two-on-each-side-of-the-aisle comfort. A four-place lounge, located in the forward part of the main cabin, will provide for relaxed reading or visiting during flight. *The new transport is designed for conversion to coach flights with a seating arrangement that provides for a total of 108 passengers, or a number of combinations in a mixed arrangement.*



THE CONVAIR "880" IS DESIGNED FOR CONVERSION TO COACH FLIGHTS. PROVIDING AN EXPANDED SEATING CAPACITY WHILE MAINTAINING THE SAME SPACE INTERVAL BETWEEN SEATS. FOR THE "COACH" CONFIGURATION. ADDITIONAL SEATS ARE INSTALLED TO GIVE THREE ABREAST SEATING ON ONE SIDE.

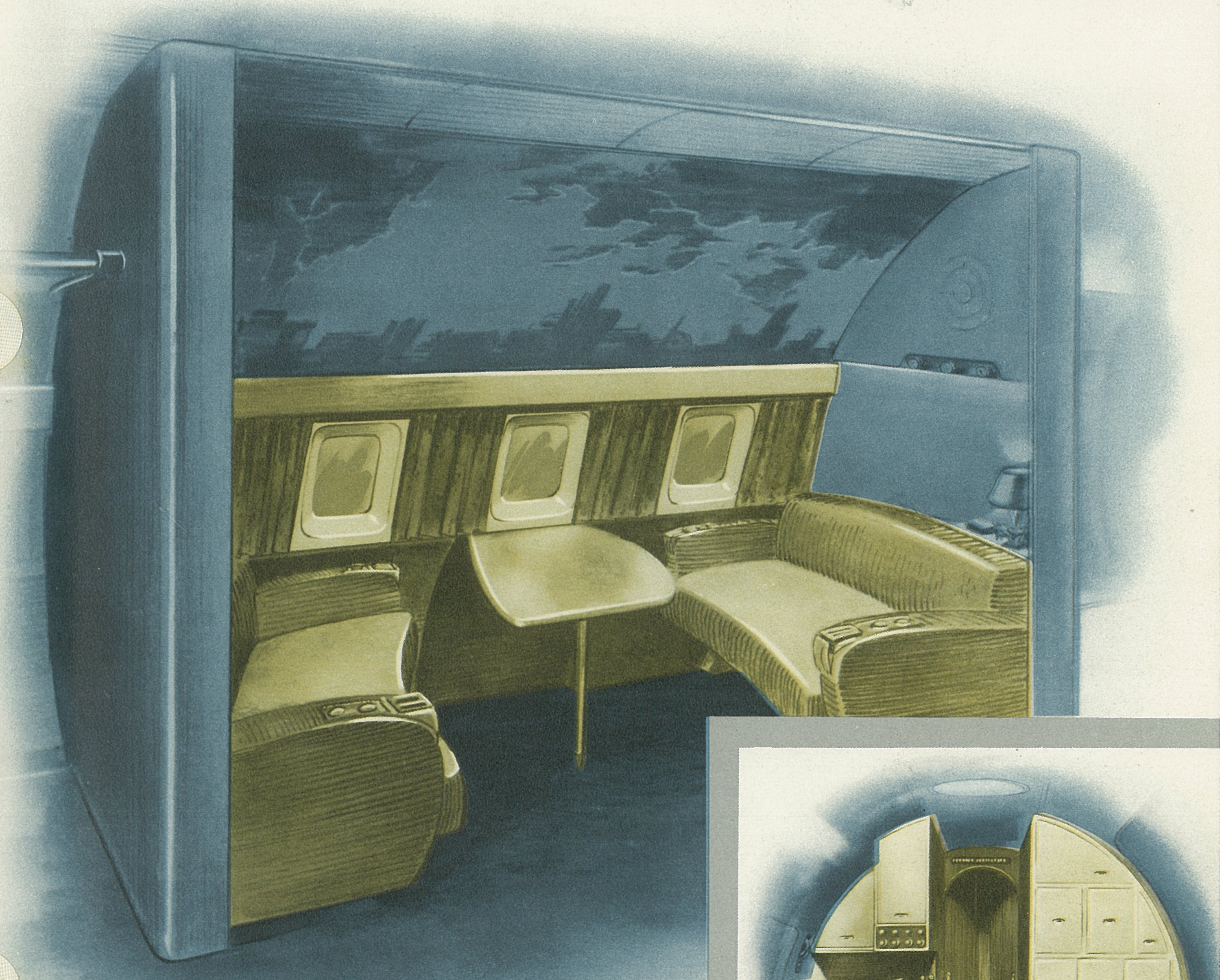
LUXURIOUS RECLINING SEATS WITH BODY-SUPPORTING CONTOUR AND RICH COVERINGS AFFORD PASSENGERS THE MAXIMUM IN COMFORT.

A FOUR-PLACE LOUNGE PROVIDES FOR RELAXED READING OR VISITING DURING FLIGHT.

MEALS ARE QUICKLY AND EASILY SERVED FROM A BUFFET THAT IS CONVENIENT. COMPACT. AND FUNCTIONAL. SPACE IS AVAILABLE FOR STORAGE OF HOT AND COLD LIQUIDS AND PREPARED FOODS OR FROZEN PACKAGED UNIT MEALS.

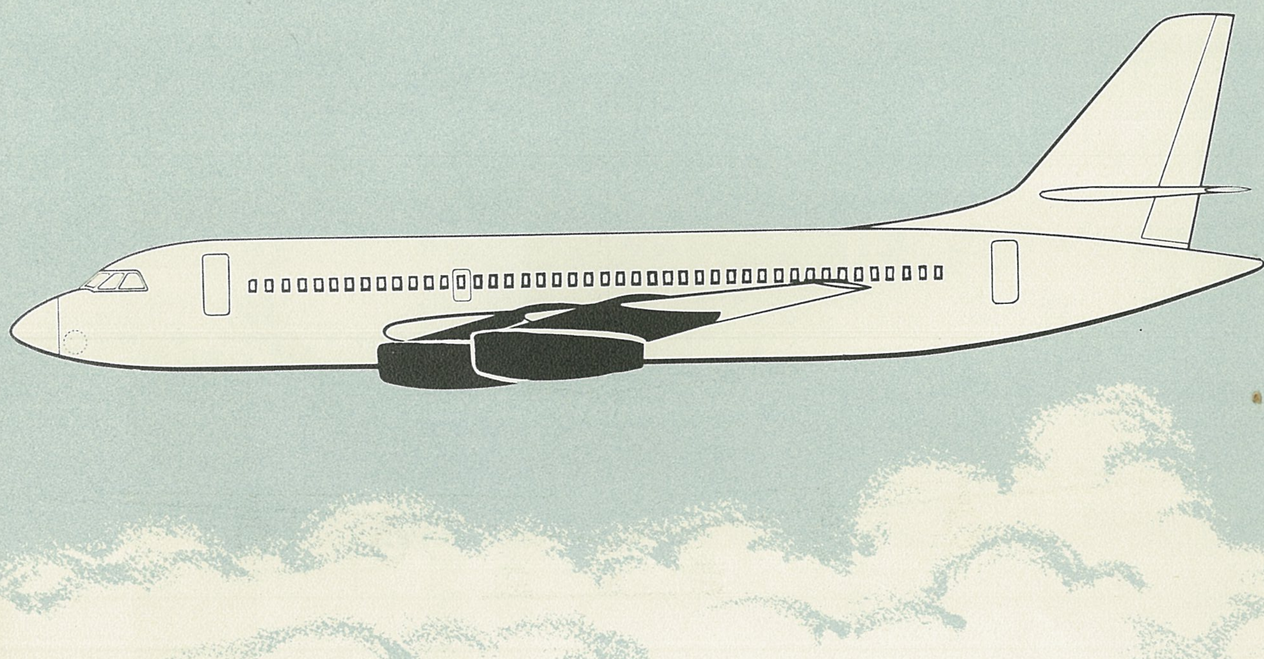
Interiors

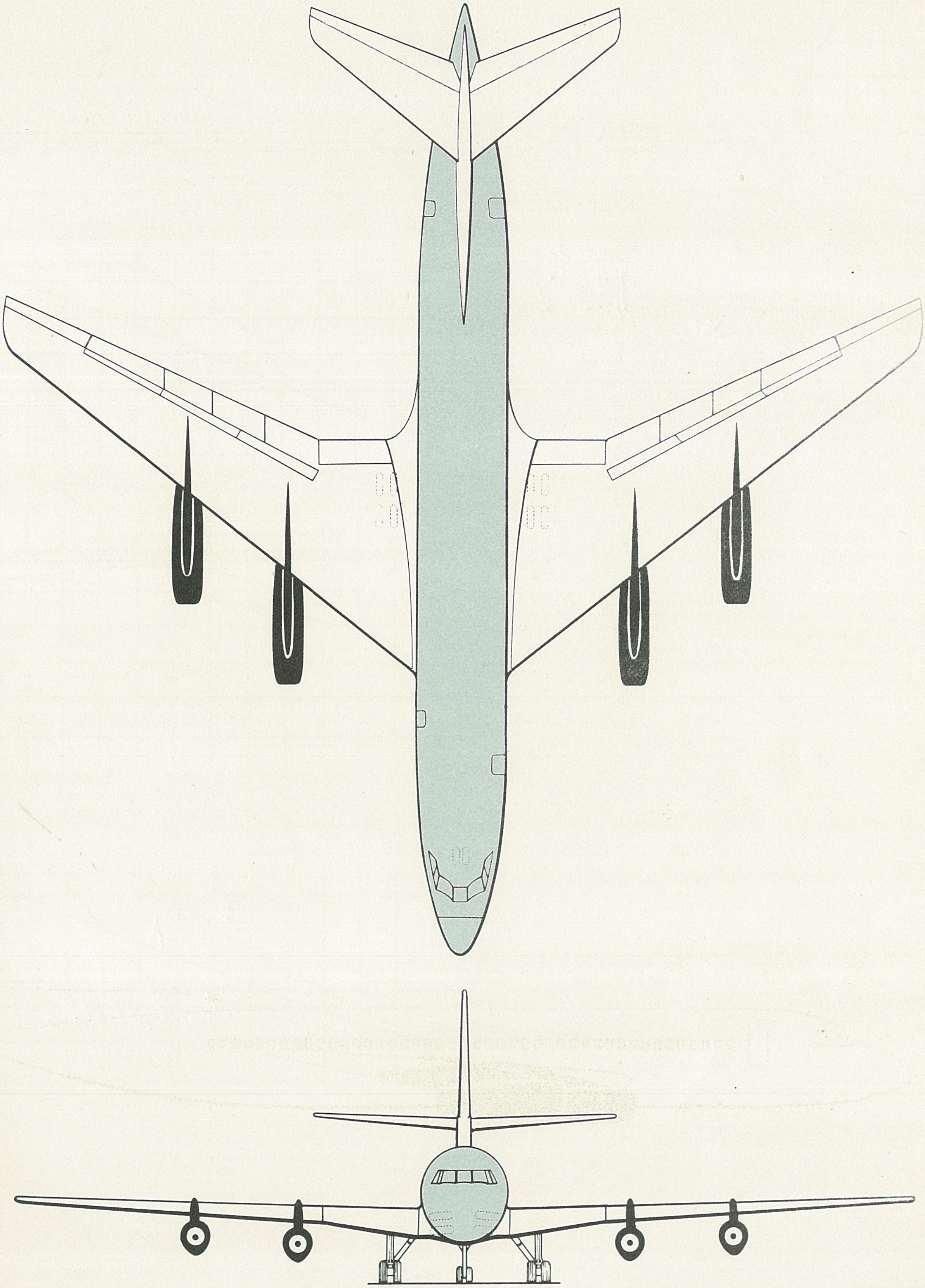
880

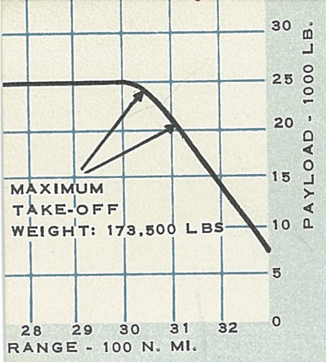


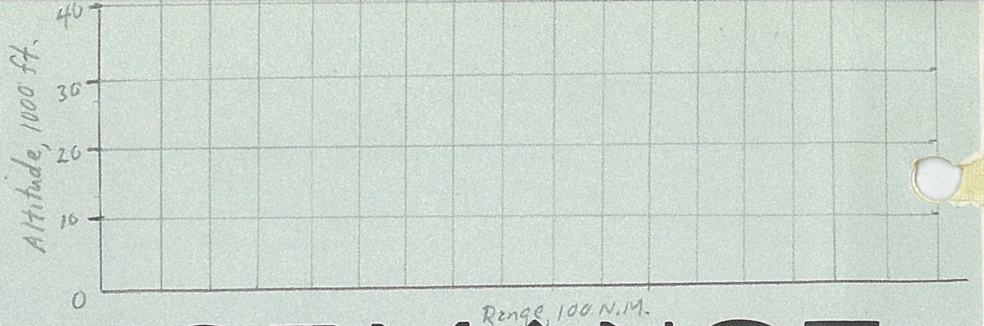
PRINCIPAL DIMENSIONS

WING	
Span — Overall	120 feet
Area — Total	2000 sq ft
Root Chord (basic)	27 ft 0.48 in.
(extended)	35 ft 8.31 in.
Tip Chord	6 ft 9.12 in.
Dihedral	5°
Aspect Ratio	7
Sweepback (30% C)	35°
M.A.C. (true)	18 ft 11.2 in.
Flaps — Type	double-slotted
TAIL	
HORIZONTAL	
Area	355 sq ft
Dihedral	7.5°
Sweepback (30% C)	35°
VERTICAL	
Area	304 sq ft
Sweepback (30% C)	35°
Top of Fin from Ground	37 ft 4 in.
FUSELAGE	
Width (maximum)	11 ft 6 in.
Height (maximum)	12 ft 5 in.
Length	124 ft 2 in.
Height — Overall	37 ft 4 in.







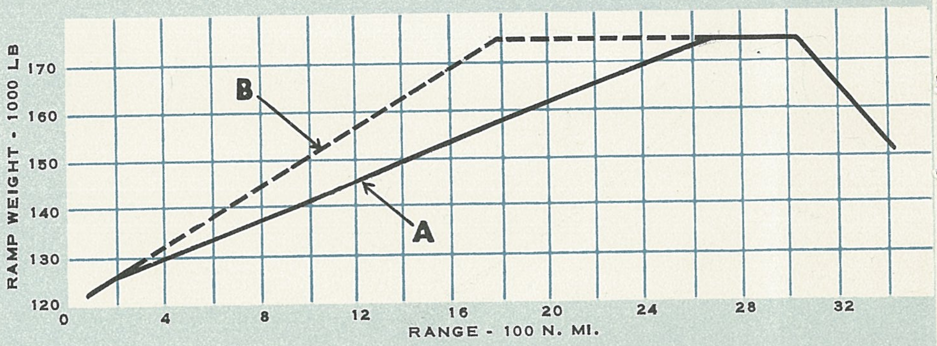


PERFORMANCE

CRUISE SCHEDULE

(A) Cruise 1 power with cruise altitude selected to give distance covered in climb and descent = cruise distance to 35,000 ft; thereafter, 35,000 ft is maintained with cruise 1 power to maximum range as limited by maximum T.O. weight. Then partial power is used at 35,000 ft to get 99% of maximum specific range.

with the altitude arbitrarily limited



(B) Maximum cruise power with altitude is arbitrarily limited to 15,000 ft at 250 N. miles, 20,000 ft at 400 N. miles and 25,000 ft at ranges greater than 600 N. miles. This holds to 1780 N. miles beyond which altitude and power are adjusted for greater range.

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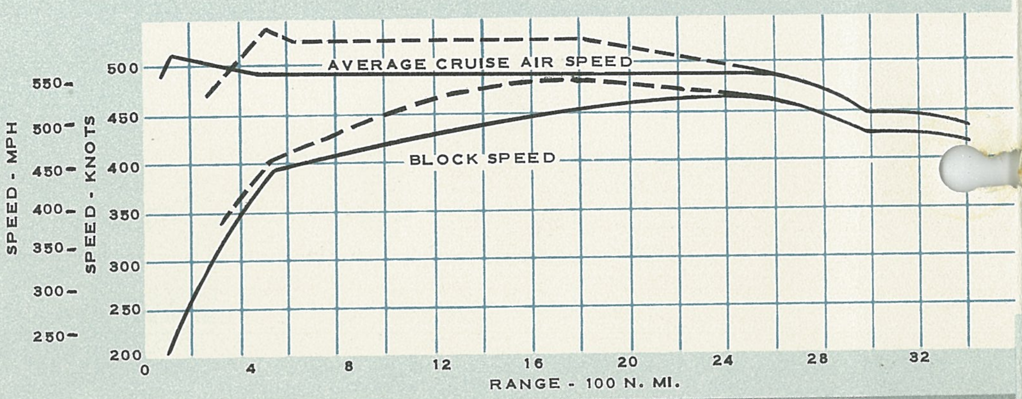
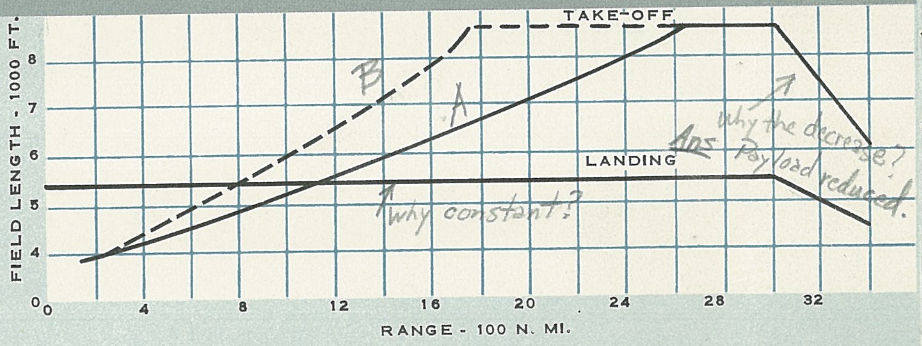


PERFORMANCE SUMMARY

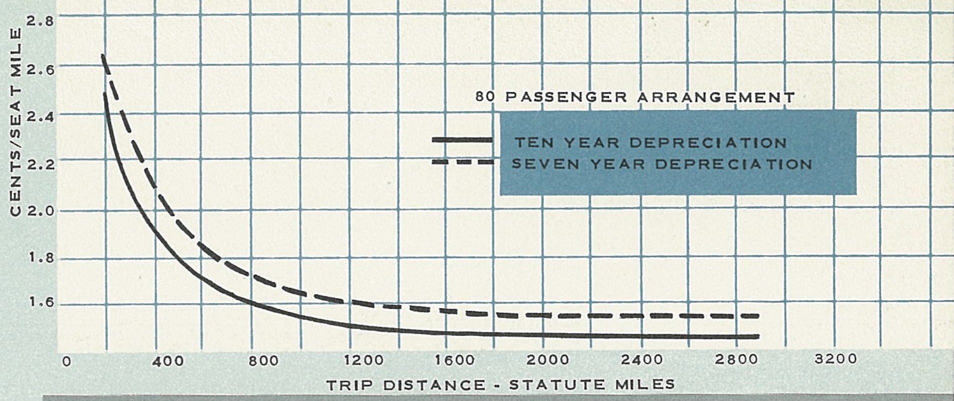
Performance of the airplane equipped with General Electric CJ-805 (J79) engines is based on engine data indicated by General Electric curves 4012162-502 through 4012162-506, Revision "C."



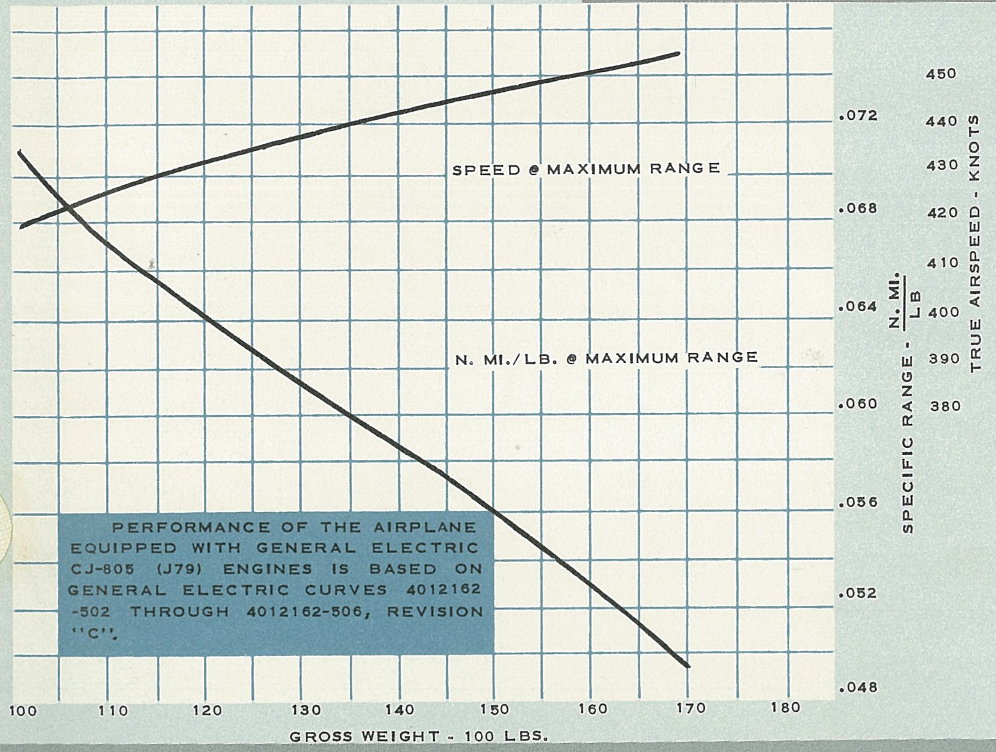
NOTES.

1. Maximum pressure differential = 7.5 psi (8,000-ft cabin at 35,000 ft).
2. V_c = 375 knots (EAS) or M_c = .89.
3. Engine data corrected for installation losses and normal accessory loads.
4. No power plant corrections for sound-suppressor installation.
5. Standard atmosphere.
6. Zero wind.
7. Anti-icing inoperative.
8. Ramp weight includes 1625 lbs of maneuver and T.O. fuel. T.O. distance obtained at lift-off gross weight.
9. Block speed includes .25 hour of maneuver time.
10. Reserve fuel is 10,000 lb, which is sufficient for 260 N. mile cruise at 25,000 ft and .75 hour hold at 15,000 ft.
11. Landing distance and T.O. distance are for sea level standard conditions. Landing weight includes the reserve fuel given in item 10. All field lengths are according to the presently proposed C.A.R.

CHARTS



DIRECT OPERATING COSTS - CENTS/SEAT MILE



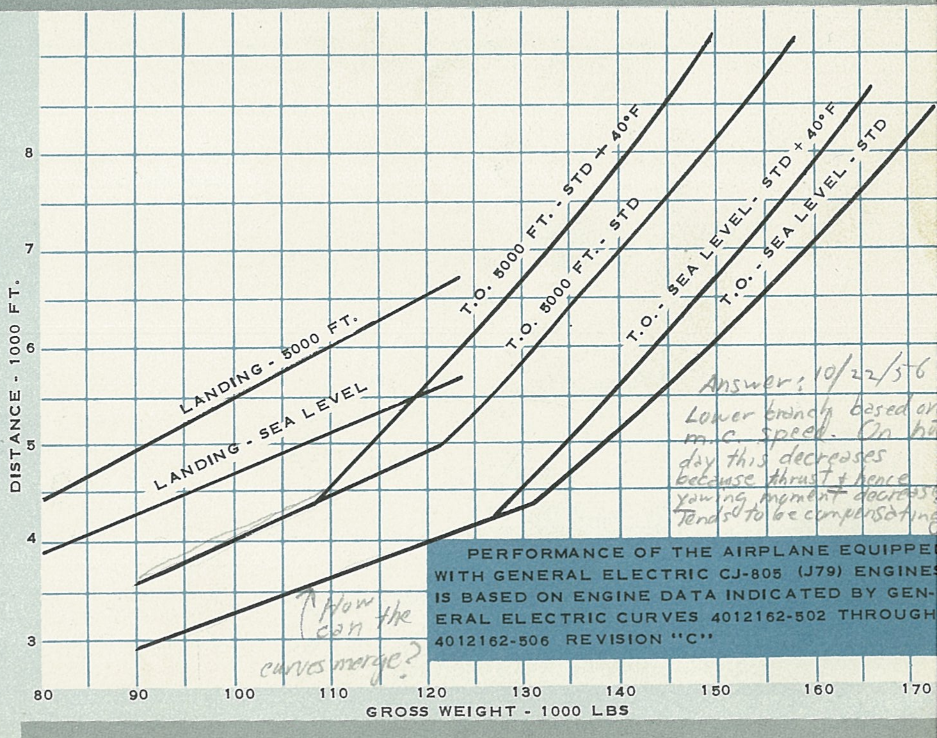
NOTES.

1. Engine data corrected for installation losses and accessory loads.
2. No power plant corrections for sound-suppressor installations.
3. Zero wind.
4. Clean configuration.
5. Standard day.
6. Anti-icing inoperative.
7. $V_c = 375$ knots, $M_c = .89$.
8. Speed for maximum range is greater of the two speeds which give 99% of maximum N. miles per pound of fuel.

MAXIMUM RANGE - AT 35,000 FT ALTITUDE

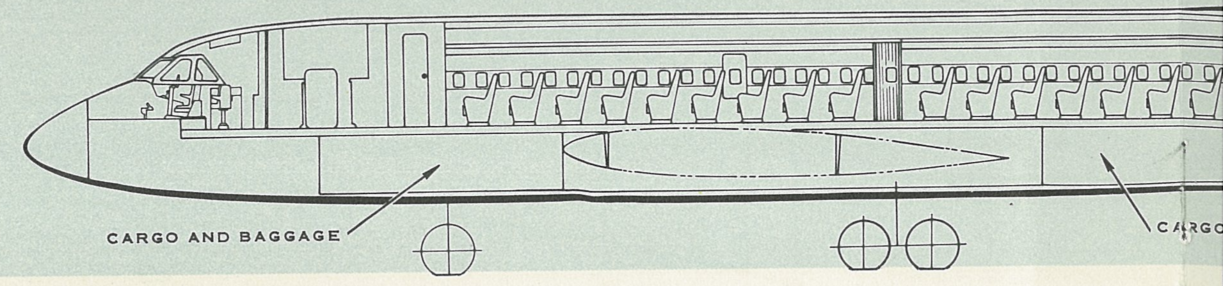
NOTES:

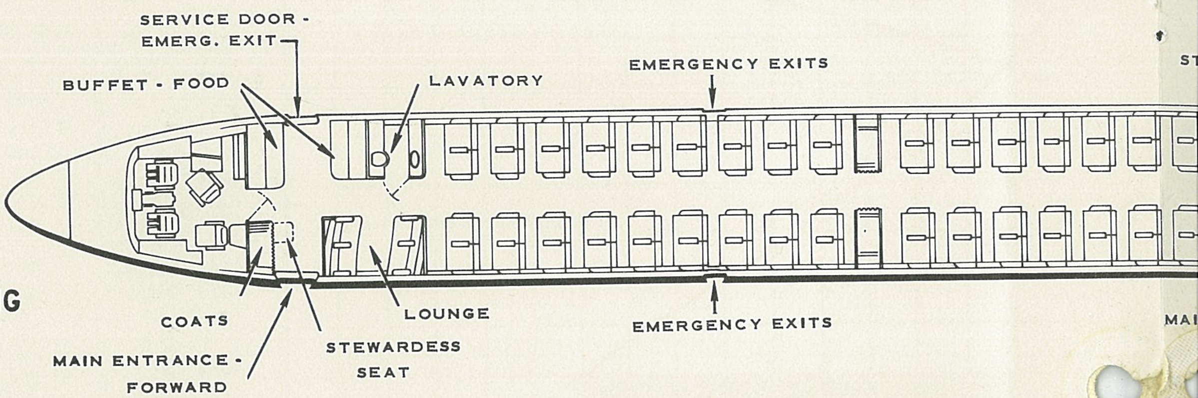
1. Engine data corrected for installation losses and normal accessory loads.
2. NACA standard atmosphere, except as noted.
3. No power plant correction for sound-suppressor installation.
4. Stopping distances include effect of anti-skid devices and full-speed brake deflection.
5. $V_{T.O} \geq 1.1\ V_{mc}$ or $1.2\ V_{s1}$.
6. 26-ft obstacle used for standard $+40°F$.
7. Zero wind.



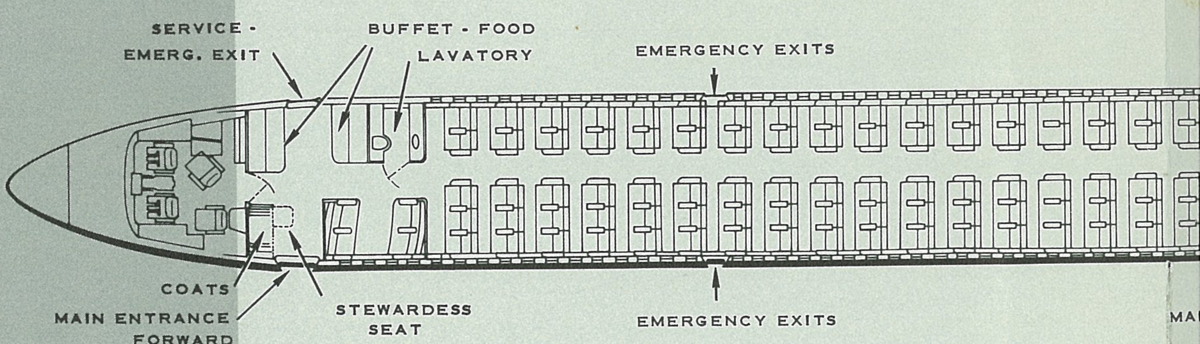
TAKEOFF AND LANDING DISTANCE VS GROSS WEIGHT

INTERIOR ARRANGEMENT





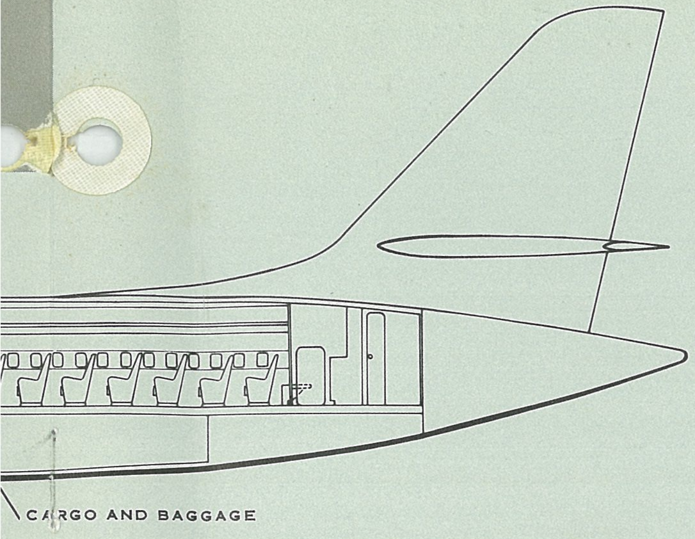
STANDARD SEATING
80 PASSENGERS

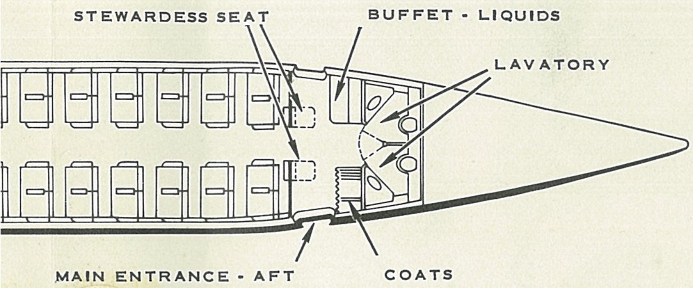


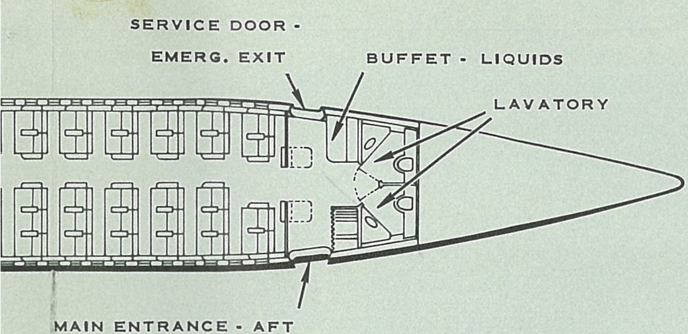
COACH SEATING
108 PASSENGERS

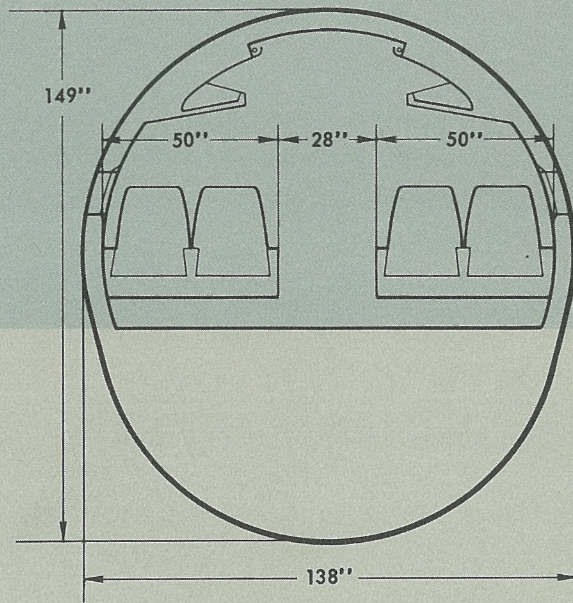
TYPICAL INTERIORS

ILLUSTRATED ARE TYPICAL STANDARD AND COACH SEATING ARRANGEMENTS. BY MOVING THE COAT PARTITIONS (SHOWN IN CENTER OF AIRPLANE - TOP TWO VIEWS), TO ANY ONE OF FIVE POSITIONS, A MIXED SEATING ARRANGEMENT OF STANDARD AND COACH CLASS SEATING MAY BE OBTAINED.

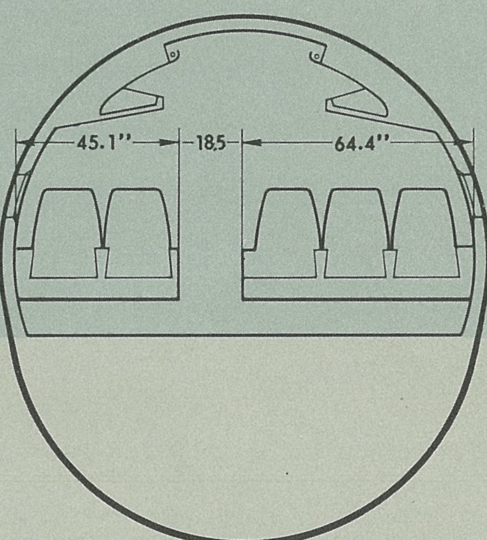








STANDARD SEATING



COACH SEATING

$P_{40} = 5.541 \text{ in Hg} = \left(0.491 \frac{\text{psi}}{\text{in Hg}}\right)(5.541 \text{ in Hg}) = 2.66 \text{ psi}$

$P_8 = 22.22 \text{ in Hg} = (0.491)(22.22 \text{ psi}) = 10.92 \text{ psi}$

$\Delta = 8.26 \text{ psi}$

GENERAL DETAILS

The crew will include a pilot, copilot, flight engineer, and three stewardesses.

Fully air-conditioned and pressurized, the "880" will carry its passengers at 40,000-foot altitudes in 8000-foot comfort. $\Delta p = 8.26$ psi

Airlines will welcome the easy maintenance and low operating costs of the new model. Many of the service-tested features developed for the economical, dependable Convair-Liners will be retained in the new aircraft . . . integral fuel tanks, easily removable cowling, and a pilot-planned flight deck. Ha, ha!

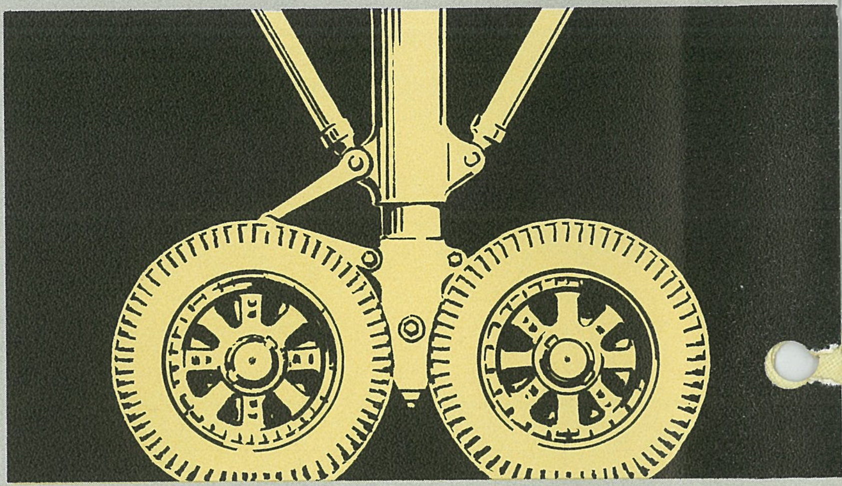
New design and production techniques, developed for supersonic military aircraft, will add speed and safety to the "880." Honeycomb sandwich panels will give structural strength with low weight, and separate Freon high-rate-discharge systems will provide increased fire protection for the power plants.

For extra safety and traction during high-speed landings, four wheels will be used in each of the two main landing gear trucks, and dual wheels will be used on the nose gear.

The swept-back wings of the new transport will span 120 feet. The 2000 square feet of lifting area will permit medium-field-length takeoffs and landings, bringing jet air travel to cities with limited runway facilities. The fuselage is 124 feet, 2 inches long, and the top of the vertical fin is 37 feet, 4 inches above the ground when the aircraft is resting on its tricycle landing gear. The wing, horizontal stabilizer, and vertical tail will be swept back at a 35-degree angle.

The Convair "880" has a maximum takeoff gross weight of 173,500 pounds, but normal takeoff weight for a typical flight against headwinds from Chicago to San Francisco, will be approximately 158,500 pounds. After a takeoff from a field length of 6850 feet (CAR field length based on climb-out with three engines over a 50-foot obstacle), the Convair "880" will climb to 40,000 feet and cruise against a 67-knot headwind for 1671 nautical miles to San Francisco, and still have fuel enough to fly 142 nautical miles at 15,000 feet to an alternate airport, and circle above the field at 15,000 feet for 1.25 hours.

Besides being the fastest commercial jet transport in the world, the "880" promises to be one of the most economical. Direct operating costs for the first-class configuration will be between 1.45 and 1.55 cents per seat-mile for ranges of 1500 nautical miles or more. Among the factors which account for this low direct operating cost are the near-sonic cruising speed and fast climb to cruising altitude. These factors contribute to the high block (ramp-to-ramp) speed of the aircraft. On flights of 500 nautical miles, block speed will be approximately 400 knots; on 1000-N-



mile flights, block speed increases to 455 knots; and on 1500-N-mile trips, it will top 475 knots.

The controls are manually operated, with the exception of the spoilers and stabilizer, which are power operated. Flight tabs reduce pilot forces on the movable surfaces.

Ailerons and spoilers are used for lateral control, the spoilers having two independent hydraulic systems. Ailerons will automatically lock out during high-speed flight. A control wheel in the cockpit will adjust the stabilizer for trimming the airplane. Spoilers are also utilized to operate as speed brakes.

The main landing gear is designed for extension at speeds up to maximum cruise speeds to serve as an additional emergency speed brake.

Flaps will be operated by a hydraulically-driven gear box located in the fuselage and connected by torque tubes to mechanical actuators at each flap section. A standby emergency system for lowering the flaps will also be provided.

THE ENGINE

The four General Electric CJ-805 turbojet engines, which power the Convair "880," combine highly compressed air with jet fuel to provide the aircraft its required thrust, efficiently. Here's how they operate.

Air enters the engine inlet, is compressed as it passes through the compressor, and then enters the combustion chamber. Here, a portion of the air is mixed with fuel and burned, and the hot gases expand through the turbine and discharge into the atmosphere. Only that energy needed to drive the compressor is used by the turbine; the remaining energy is utilized in a propulsive jet as the hot gases are expanded through a nozzle.

An engine starter is necessary to turn the compressor to start the flow of air, but after the air begins to flow into the engine, compression is continuous and automatic. Engine speed adjustment is provided by the fuel control, and close control over thrust and exhaust temperatures is maintained.

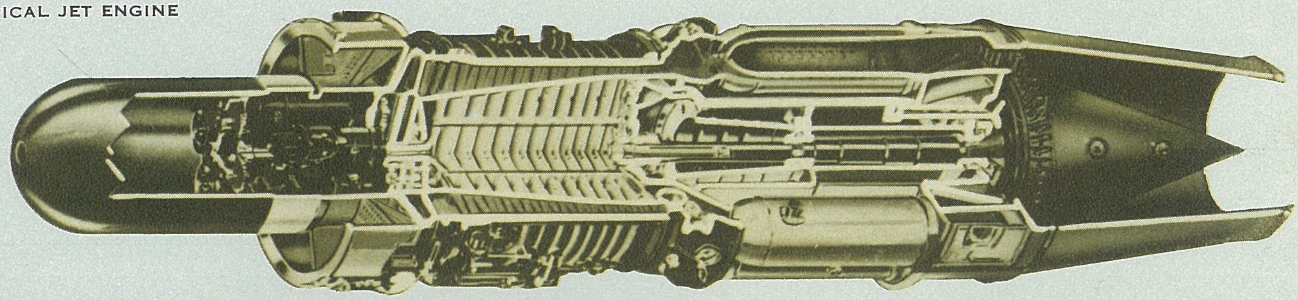
The simplicity of the jet engine facilitates maintenance. There are no magnetos or carburetors which require delicate adjustment and cleaning. Overhauls are easier, too, because there are relatively fewer moving parts subject to mechanical wear and friction.

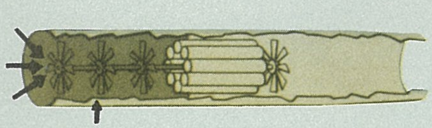
Fuel control instead

Jet engines are reliable and rugged. Aircraft powered by the J47, military predecessor to the CJ-805, are being flown over 5½ million miles every day in all kinds of weather and under a wide variety of operating conditions. The Air Force has extended overhaul periods on the engine, which powers such aircraft as the B-36, B-47, B-45, and F-86, to 1700 flying hours. This is the longest overhaul period permitted by the Air Force for any axial-flow turbojet, and is the equivalent of 30 jet flights around the world.

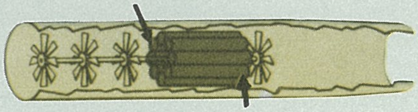
General Electric has built over 31,000 jet engines since 1941. Experience and know-how . . . 15 years of it . . . are built into the "880's" four CJ-805 engines. These new engines will have even greater reliability than the J47, as a result of the background of many years of operation and service with the J47. They will pack more thrust per pound of weight than other jet engines in their power class.

TYPICAL JET ENGINE

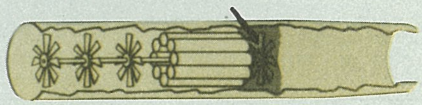




Air enters the engine through the front intake. The compressor, acting like a large fan, compresses the air several times atmospheric pressure and forces it through ducts to the combustion chambers.

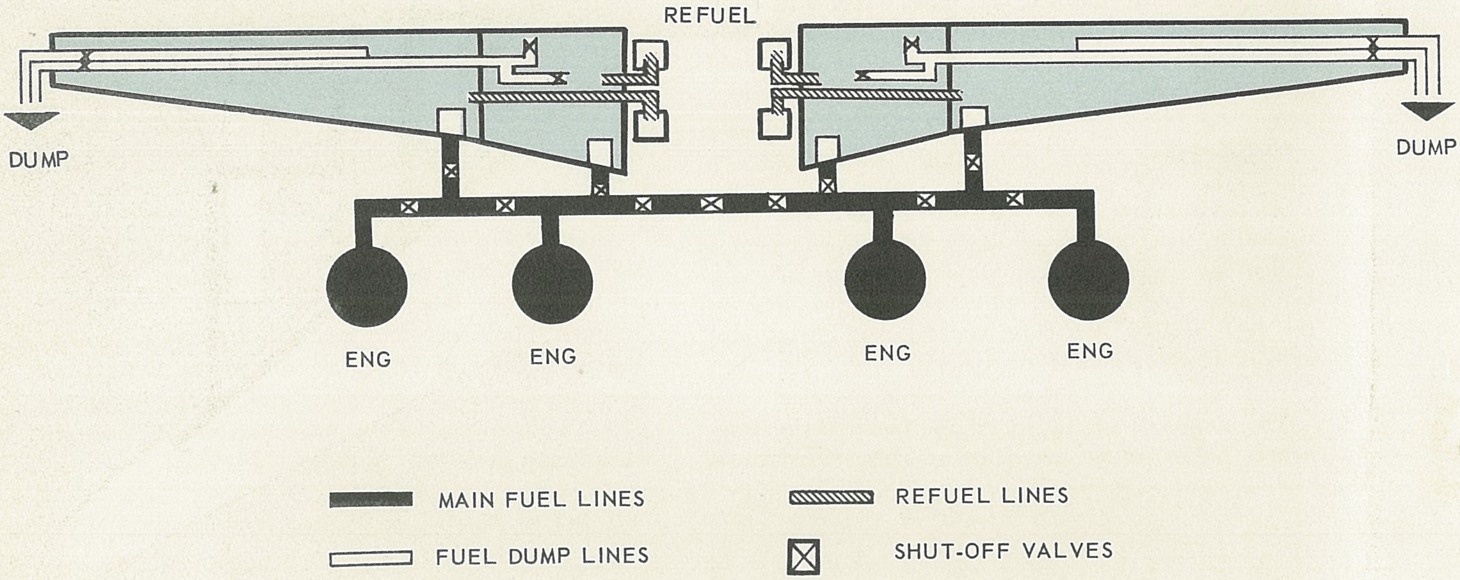


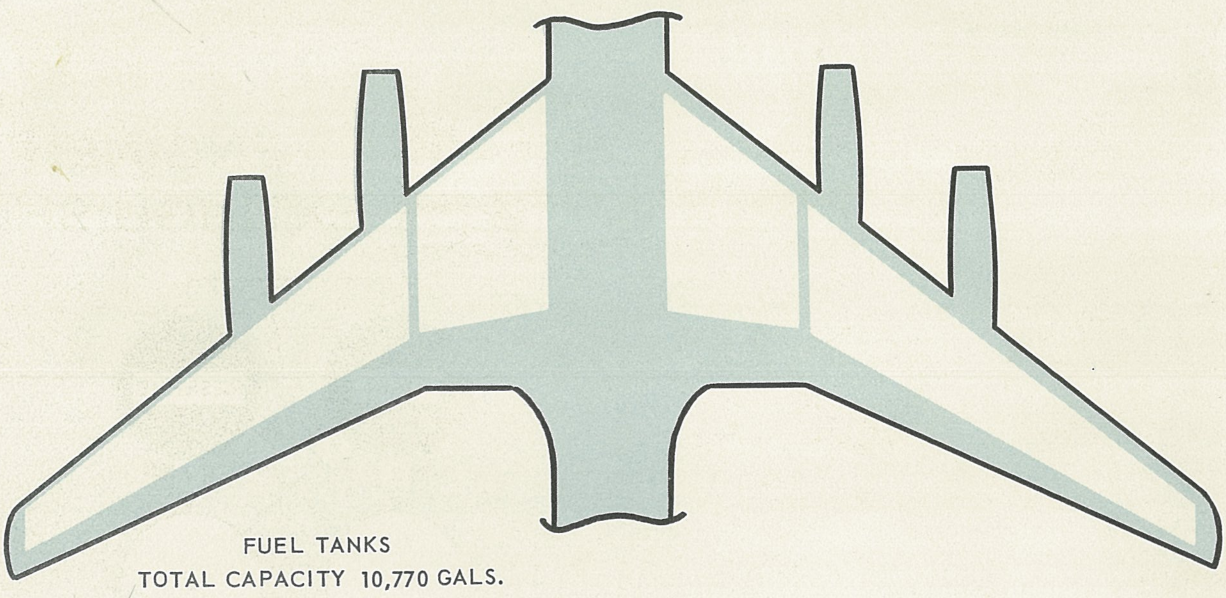
In the combustion chambers, fuel is sprayed into the compressed air and ignited. The resulting fire rapidly expands the hot gases and accelerates them out the rear of the engine. This jet blast gives the engine and airplane its enormous forward thrust.



As the hot gases rush out the engine, they pass through a set of blades, the turbine wheel. These blades, turning the main engine shaft, transmit force to the compressor which packs in more fresh air.

FUEL SYSTEM

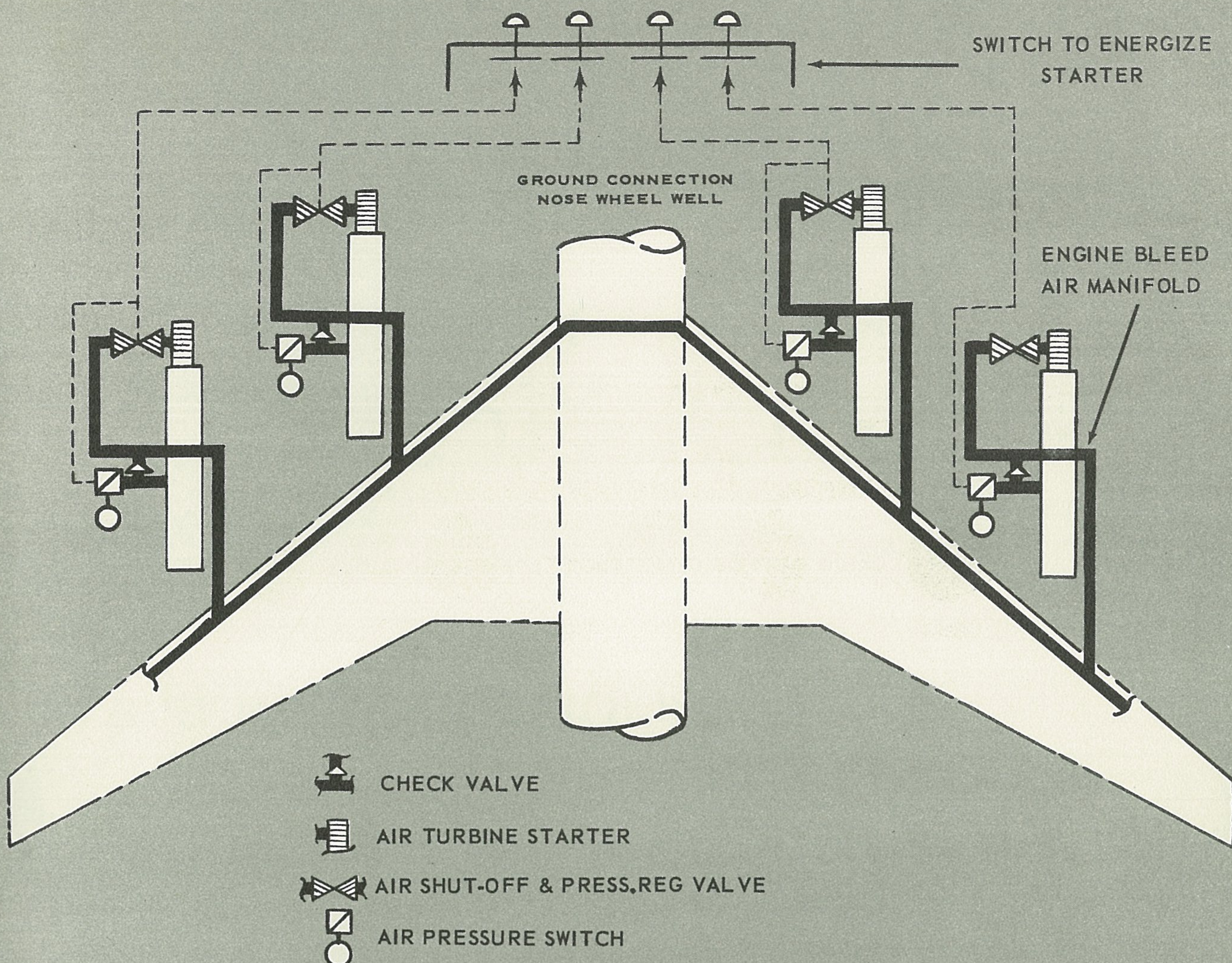




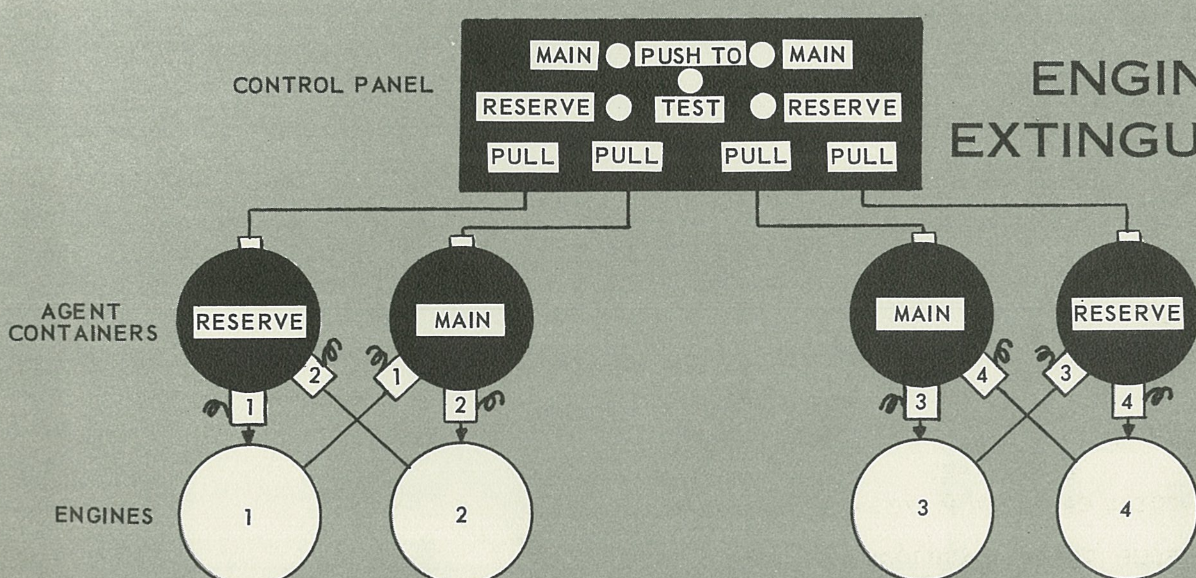
TOTAL CAPACITY 10,770 GALS.

FOUR TANKS OF APPROXIMATELY EQUAL CAPACITY

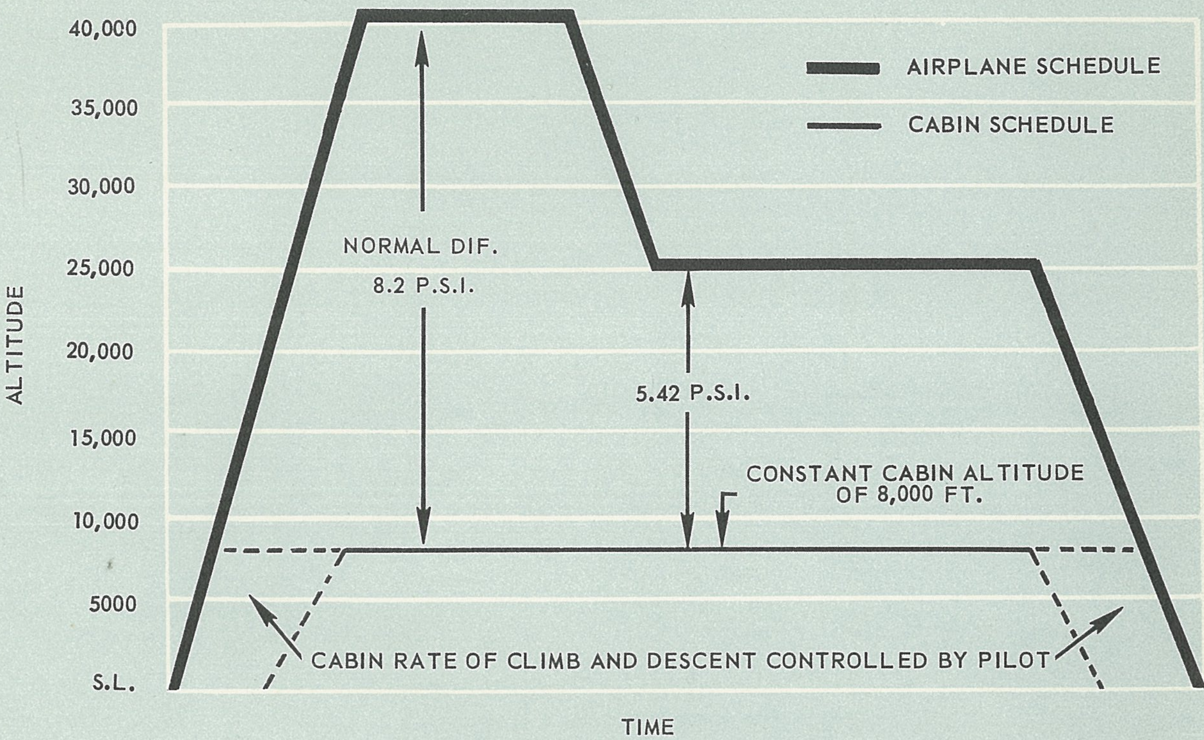
STARTING SYSTEM



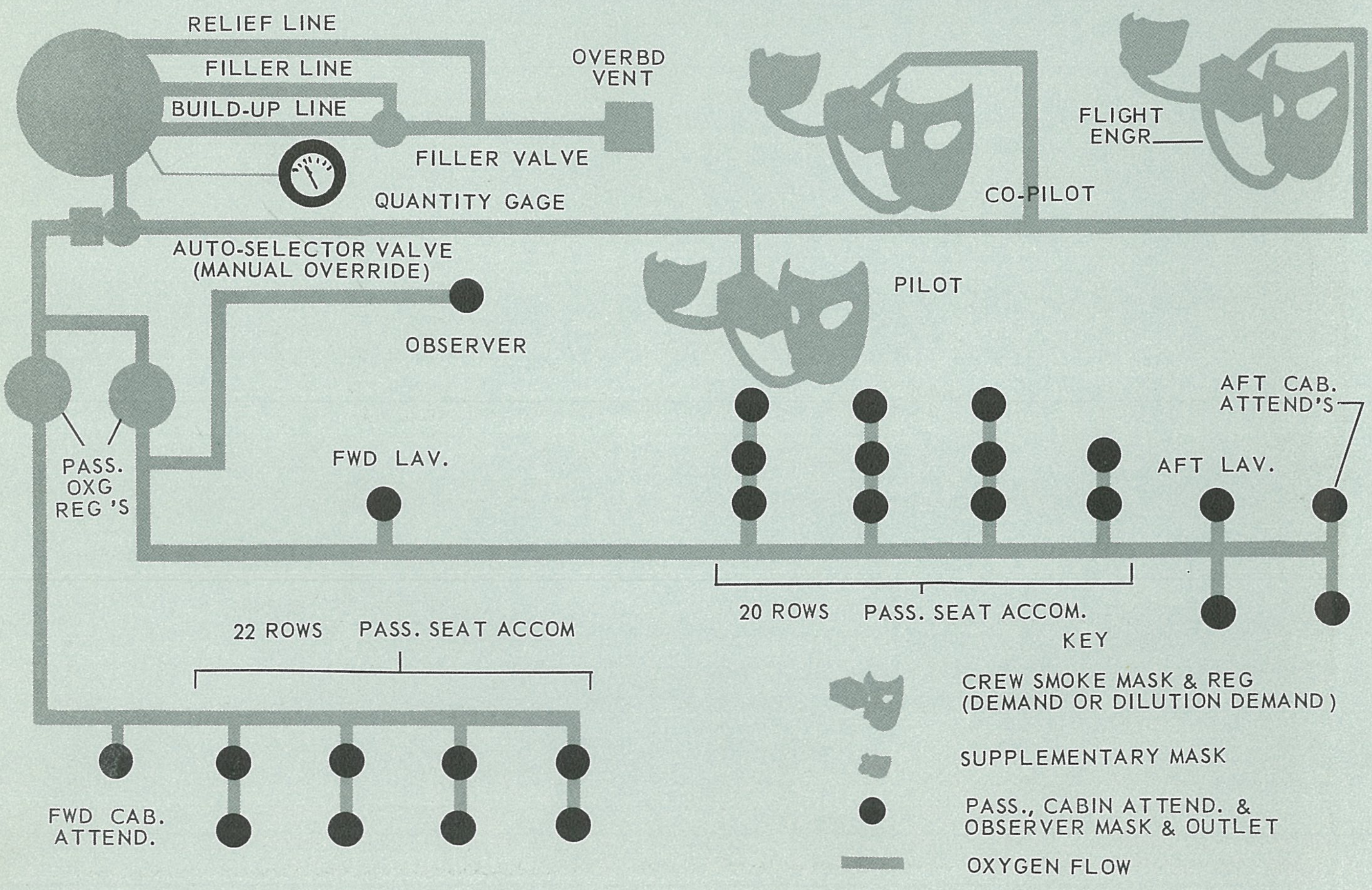
ENGINE FIRE EXTINGUISHING



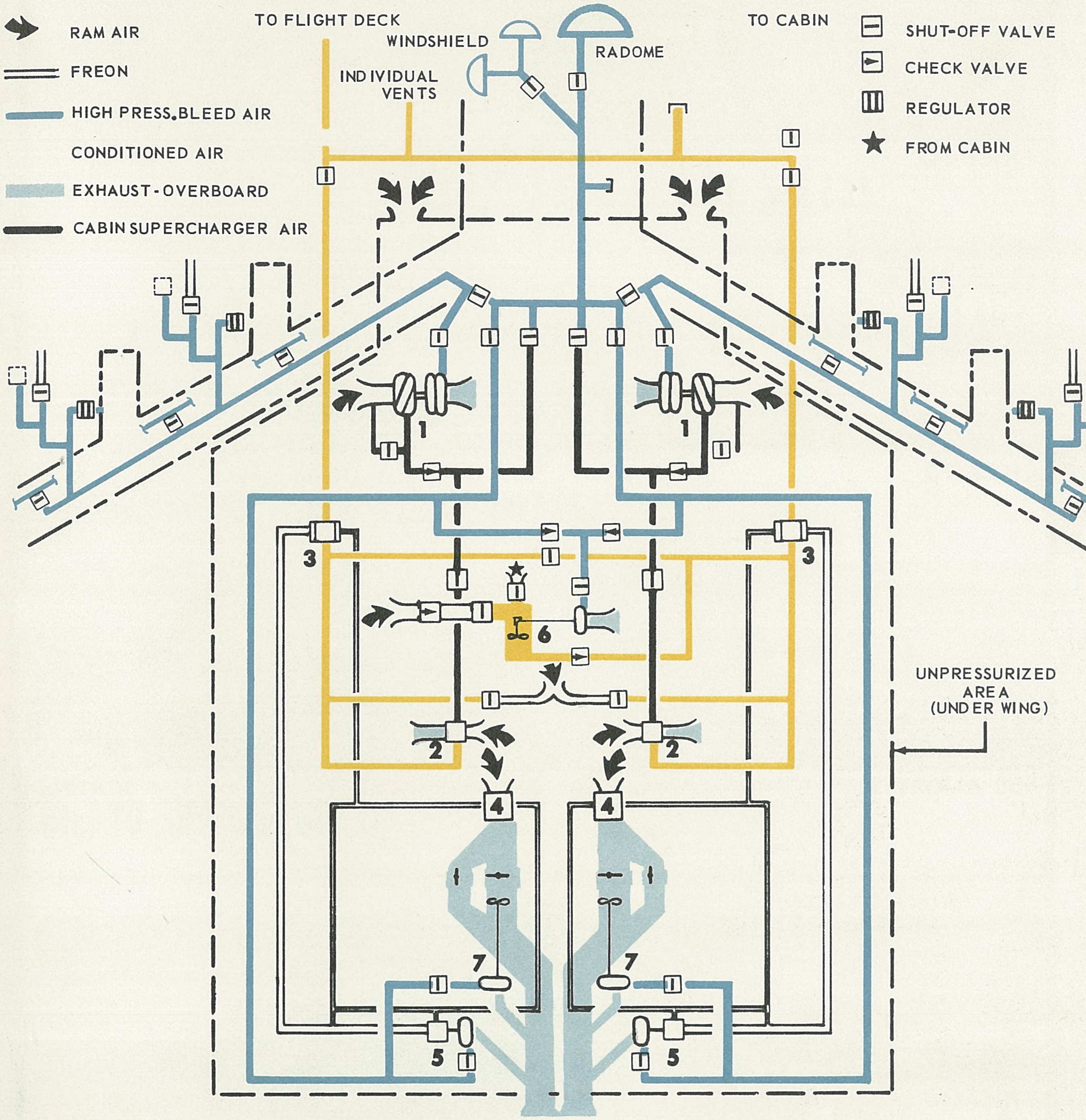
CABIN PRESSURIZATION SCHEDULE



LIQUID OXYGEN SYSTEM



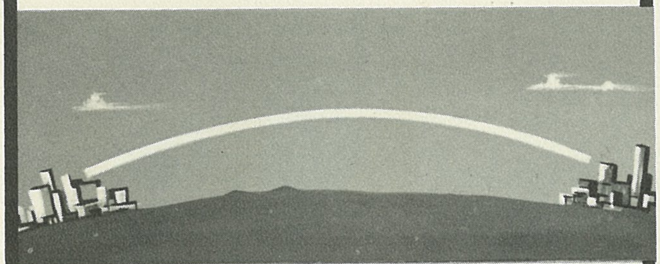
AIR CONDITIONING, PRESSURIZATION AND ANTI-ICING



	35000FT.	SL GROUND
CABIN AIRFLOW	120 LB/MIN	160 LB/MIN
HEATING SYSTEM (COMPRESSOR HEAT)	75° CABIN @-80° F	75° CABIN @-40° F
COOLING SYSTEM (TWO TEN-TON FREON SYSTEMS)	75° F IN FLIGHT	80° F @100° F & 50% R.H.
CABIN AIR RATE-OF-CHANGE - COMPLETE CHANGE EVERY 2½ MIN.		

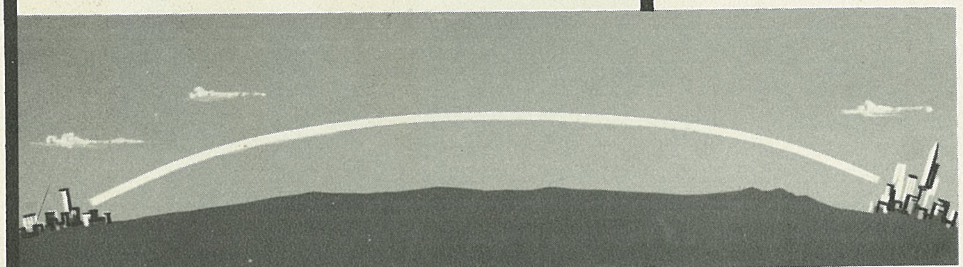
1 CABIN AIR COMPRESSOR *
2 HEAT EXCHANGER
3 EVAPORATOR
4 CONDENSOR
5 FREON COMPRESSOR *
6 CABIN AIR RECIRCULATING * FAN
7 CONDENSOR COOLING * AIR FAN

* ATM DRIVEN



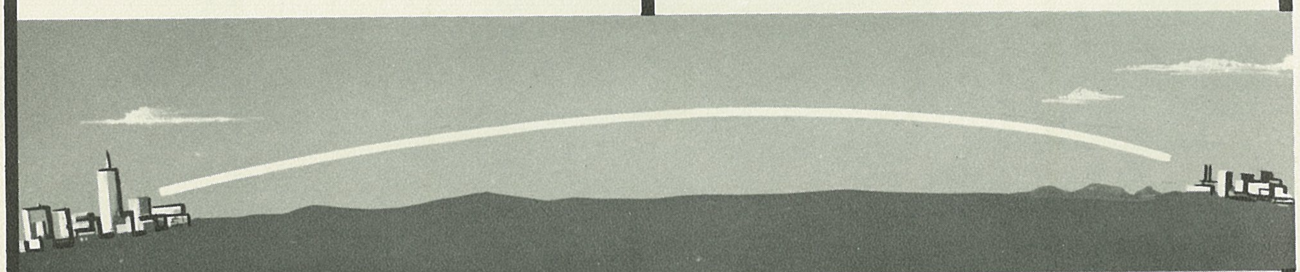
CHICAGO — KANSAS CITY

405 mi. 1 hr. 02 min.



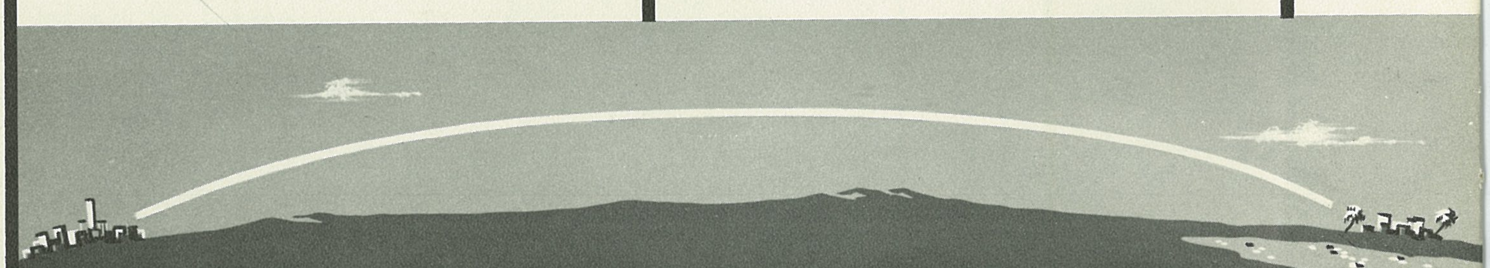
CHICAGO — NEW YORK

724 mi. 1 hr. 36 min.



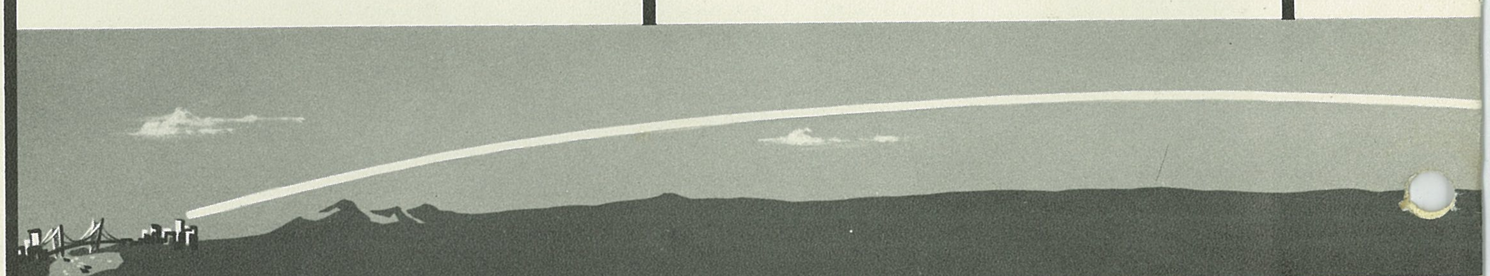
LOS ANGELES — SEATTLE

957 mi. 2 hr. 01 min.



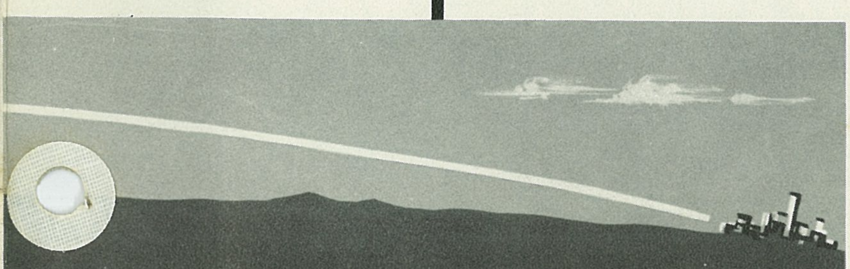
CHICAGO — MIAMI

1181 mi. 2 hr. 24 min.



SAN FRANCISCO

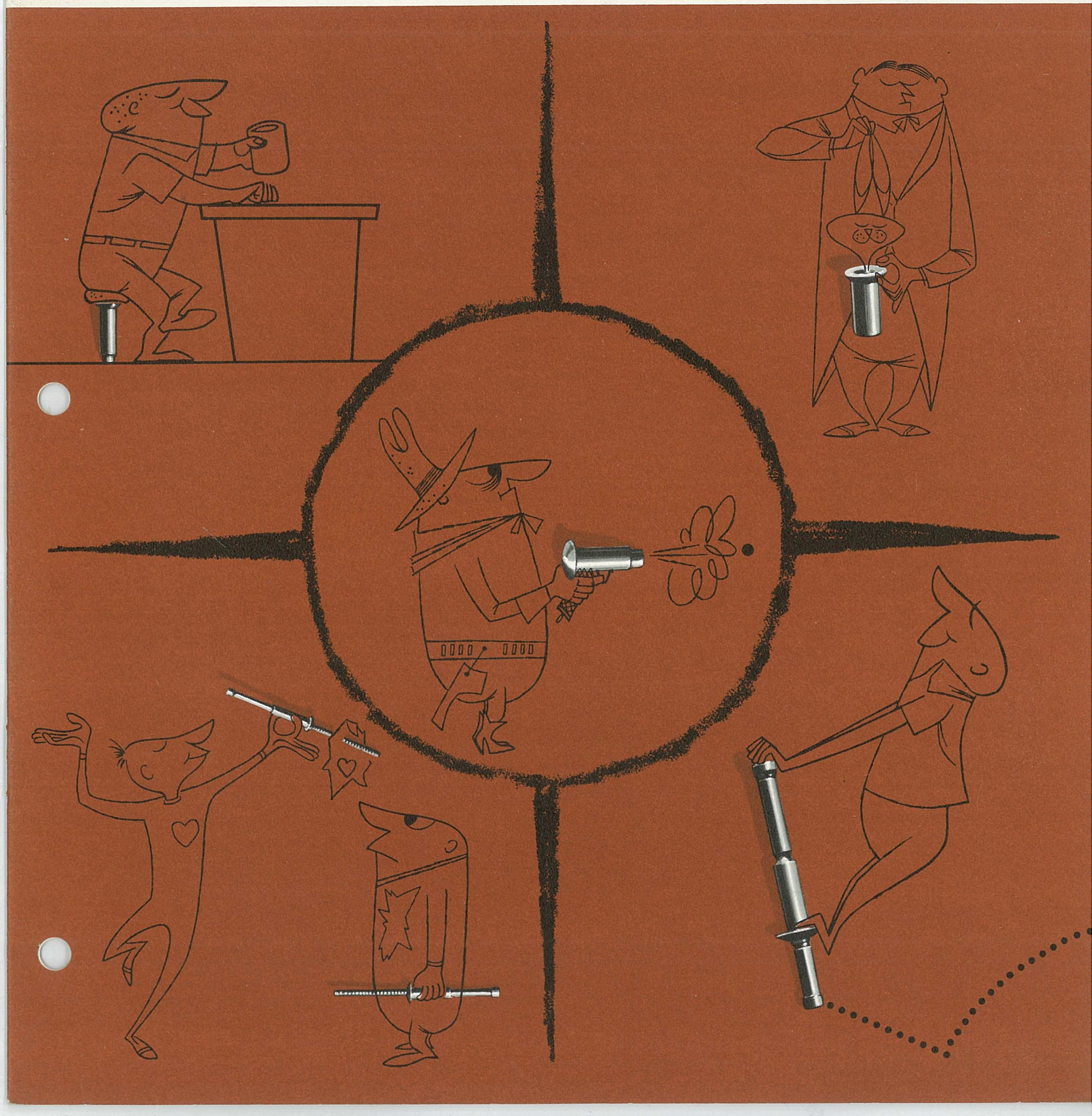
the Convair 880



CHICAGO

1856 mi. 3 hr. 36 min.

CONVAIR
Traveler
VOLUME VIII NUMBER 7 NOVEMBER 1956



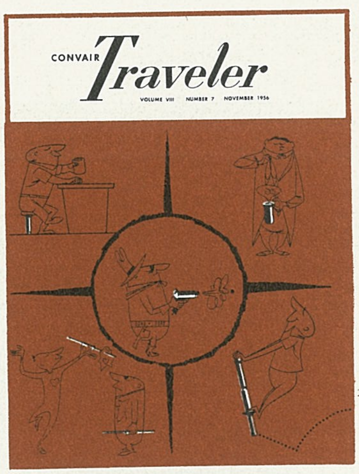
CONVAIR *Traveler*

VOL. VIII NO. 7 NOVEMBER 1956

FOREWORD

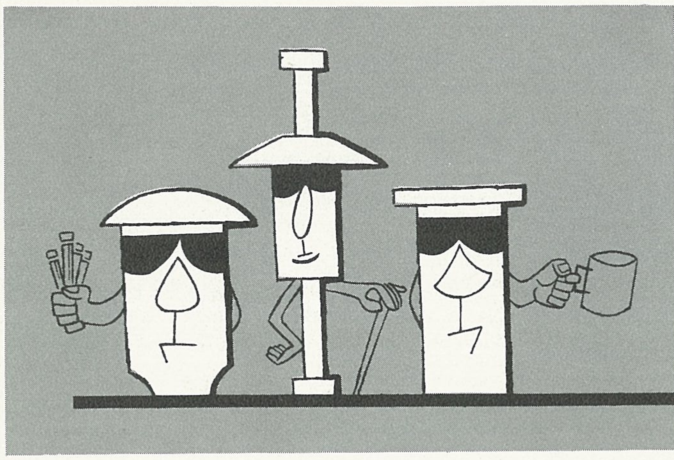
Rivets are important items in aircraft production and maintenance. They are important not only from the standpoint of cost, but also because the structural integrity of the aircraft and the consequent safety of the passengers and crew are often dependent on the skill and knowledge of the men who install the rivets.

This month the Traveler contributes to that skill and knowledge with an issue devoted to the installation of Self-Plugging, Explosive, and Rivnut blind rivets . . . the three types of blind fasteners which are most frequently used in aircraft structures.



On the Cover
You can do anything with blind rivets . . . well, almost anything. On our cover this month, artist Willis Goldsmith portrays a few unusual applications for oversize rivets and undersize people . . . none of which are Convair recommended.

A digest of Convair-Liner operation and service published monthly by the Service Publications Section of Convair in the interest of Convair-Liner operators. Communications should be addressed to Manager of Service, Convair, San Diego 12, Calif.



BLIND RIVETS

Riveting is one of the strongest, most satisfactory methods of fastening materials . . . it is also one of the oldest methods. Among primary reasons for the success of rivet fasteners in the aircraft industry is the ease with which rivets can be adapted to many applications in manufacture and maintenance.

One example of the versatility of this fastening method is the development of "blind" rivets for use in those areas where it is impossible, because of space limitations or inaccessibility, to perform a "bucking" operation. These rivets are worked with a special tool from the top side only. Three types of blind fasteners, the Self-Plugging, Explosive, and Rivnut rivets, will be discussed in this issue to provide a readily available source of information on the installation of special rivets. This information is for reference only and is subject to change. Engineering drawings and/or vendor data should be consulted for up-to-date specific information.

Most of the principles of good riveting and hole preparation apply equally to blind and standard rivet installations; however, when blind rivets are driven, it is seldom possible to inspect the blind side of the work. For this reason, special precautions, such as driving test rivets in a trial sample of material of the same gage may be necessary to assure correct fit.

If the following fundamentals of drilling are observed many common mistakes can be avoided:

1. Prior to drilling, determine correct hole diameter, rivet size and head style from the applicable engineering drawing. Choose a clean, sharp drill of smaller diameter than the finished hole; drill a pilot hole, then re-drill to correct size.
2. Hold the drill at a 90° angle to the work. *Do not force it through the material.*
3. To insure proper alignment, hold the sheets firmly together with "Cleco" fasteners or clamps while they are being drilled. Always use enough fasteners so that there will be no looseness of the parts being riveted, and no chance for the rivet to upset or swell between the sheets. Remove all foreign substances from between material.
4. Remove burrs from the hole. The presence of burrs may prevent the head from seating properly, cause sheet separation, and result in a poor structural assembly.

After the holes have been prepared, the following procedure will assure correct installation of rivets.

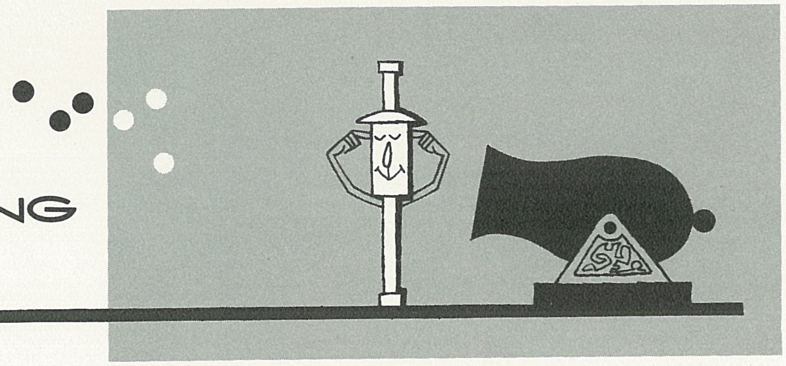
Determine the rivet grip length required for any application, by measuring the total thickness of material with a hook scale through the rivet hole. This measurement, which must be made with the parts clamped, will include variations due to tolerances in sheet thickness, primer, and any spaces existing between the sheets due to irregularities in contour. Whenever the measurement is within a few thousandths of the maximum or minimum of a grip range, drive a few test rivets into material of the same gage before a final selection of grip length is made.

In the case of dimpled holes, the measurement will include the height of the dimple. A normal dimple produces a bellmouth which does not allow a blind rivet to form its head properly. Before dimpling, drill holes undersize; use an undersize pilot on the dimpling tool and size-drill after dimpling. This procedure produces a dimple with a cylindrical hole which allows the formation of a stronger blind rivet.

When countersunk rivets are to be driven slightly above flush, add the amount of head protrusion to the material thickness.

Rivet in the proper order. Start at the center and rivet toward the outside edge; otherwise, the skin may not fit because of creeping.

SELF-PLUGGING RIVETS



Self-plugging blind rivets, manufactured by the Townsend (Cherry), Huck, and Olympic Companies, are assemblies which consist of a hollow sleeve and an inner stem. The products of all three companies are similar in appearance and function, and all three companies manufacture rivets which conform to Military Standards No. 20600 and No. 20601, the Armed Forces specification for protruding and countersunk self-plugging rivets.

Self-plugging rivets must be set by a special tool which grips the stem. When the stem, which is wider on the blind side, is pulled into the sleeve, the sleeve expands, filling the hole completely. A preformed head on the blind side of the rivet core forms a tulip-shaped upset on the sleeve and draws it tightly against the blind side of the sheet. When the rivet is set, the stem breaks off in tension, leaving the remaining portion, as a tight plug, in the center of the rivet.

After installation, a special trimming tool, which operates from an electric (or air) motor, spin-trims the protruding portion of the stem, and flattens the stem securely against a seat in the rivet head. When rivets, which join materials with a total thickness of less than .064 inch, are being trimmed, there is a possibility that a spinning action may loosen the stem. There are also instances in which the rivets are inaccessible to a special trimmer. In each of these cases, flat-faced snippers should be used.

Special guns, used for installing self-plugging rivets, are manufactured in many different designs to fit every need. Small hand guns, suitable for field maintenance depots, and pneumatic guns for high production applications, are available with a variety of nose assemblies for all rivet sizes and head types.

Each rivet may be inserted into the jaws of the gun as it is driven, or a number of rivets may be inserted into the holes prior to riveting. In hard-to-reach places, the former method is preferred, because the jaws of the gun grip the rivet stem and hold it firmly in place; however, when large numbers of rivets are to be driven, the latter method is more efficient.

To operate a self-plugging rivet gun, slip the drawbolt slot onto the rivet stem. Be sure the stem is seated at the bottom of the slot. Hold the gun firmly and squarely against the head of the rivet and in line with the rivet stem. A steady pressure against the head is necessary. To install the rivet, press the trigger or, if a hand gun is used, squeeze the handles together. Continue to operate the gun until the rivet is set and the stem breaks off in tension.

To test the soundness of the stem in an installed self-plugging rivet, a special inspection gage should be used. This is a spring-loaded punch, which automatically applies a controlled impact to the stem. Testing should not be accomplished with heavy pressure or sharp blows. The following table shows the acceptable push-out pressures for self-plugging rivets.

Nominal Rivet Diameter	1/8	5/32	3/16	1/4
Stem Push-Out Pressure	15	25	35	50

**PART NUMBER IDENTIFICATION
CHERRY RIVETS**

CR157 -6 -4

- -4: Nominal grip length in 32nds
- -6: Rivet Shank diameter in 32nds
- CR157: Series number designating material, style, head type

PART NUMBER IDENTIFICATION
HUCK RIVETS

9SP B R 8 11 U

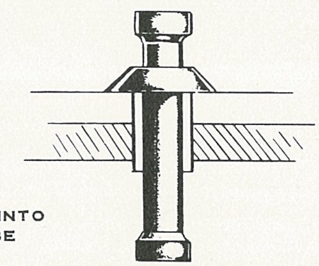
- U designates unichrome-coated sleeve.
  C designates cadmium-plated sleeve
- 11 — Grip length as specified in table
- 8 — Rivet diameter in 32nds
- R — Material designation
  - A = pin: 2017 alum.
    sleeve: 2117 alum.
  - B = pin: 2017 alum.
    sleeve: 5056 alum.
  - R = pin: mild steel,
    rust-proof coating.
    sleeve: mild steel,
    unichrome-plated.
- B — Head type designation:
  - B = protruding
  - 100 = countersunk
- 9SP — Rivet design series

PART NUMBER IDENTIFICATION
OLYMPIC RIVETS

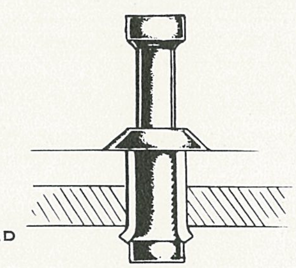
RV 2 5 0 -4 -2

- -2 — Grip length maximum in 1/16ths
- -4 — Shank diameter in 1/32nds
- 0 — Head Style
  - 0 = protruding head
  - 1 = countersunk
- 5 — Material
  - 5 = 5056 aluminum alloy
  - 9 = Monel
- 2 — Rivet Type
  - 2 = self-plugging
- RV — Riv-Tite

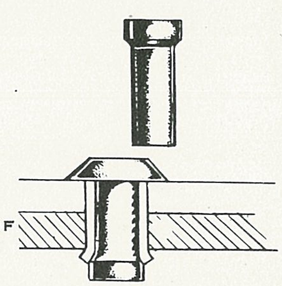
SELF-PLUGGING RIVET BEFORE INSTALLATION.



RIVET IS INSERTED INTO THE MATERIAL TO BE JOINED.



RIVET STEM IS PULLED INTO THE SLEEVE.



TULIP-SHAPED HEAD IS FORMED ON BLIND SIDE OF MATERIAL; STEM BREAKS OFF IN TENSION.

SELF-PLUGGING RIVETS

RECOMMENDED HOLE SIZES

RIVET DIAMETER	PRE-DRILL SIZE DRILL #	PRE-DRILL SIZE HOLE	FINISH SIZE DRILL #	FINISH SIZE HOLE	HOLE DIA LIMITS
1/8	32	.116	30	.128	.129 - .132
5/32	26	.147	21	.159	.159 - .163
3/16	16	.177	11	.191	.191 - .196
1/4	A	.234	F	.257	.256 - .261

SELF-PLUGGING RIVETS

GRIP RANGE CODE

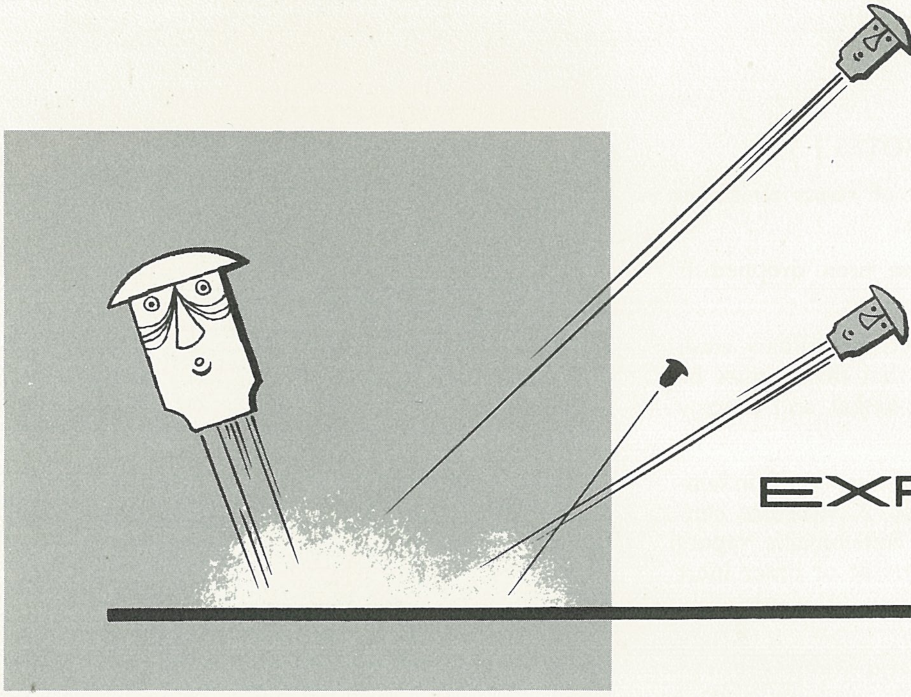
GOVERNMENT PART NUMBERS

FINAL DASH NUMBER	GRIP RANGE MIN	GRIP RANGE MAX	FINAL DASH NUMBER	GRIP RANGE MIN	GRIP RANGE MAX
-1	UP TO	.062	-8	.438	.500
-2	.063	.125	-9	.501	.562
-3	.126	.187	-10	.563	.625
-4	.188	.250	-11	.626	.687
-5	.251	.312	-12	.688	.750
-6	.313	.375	-13	.751	.812
-7	.376	.437	-14	.813	.875

BLIND, SELF-PLUGGING, 5056 ALUMINUM RIVETS

GOVERNMENT AND MANUFACTURERS PART NUMBERS

GOVERNMENT PART NUMBERS	CHERRY PART NO.	HUCK PART NO.	OLYMPIC PART NO.
MS20600B4-(1-6)	CR157-4-(2-12)		RV250-4-(1-6)
MS20600B4-(1-2, 3-4, 5-6)		9SP-B-B4-(1, 3, 5)	
MS20600B5-(1-8)	CR157-5-(2-16)		RV250-5-(1-8)
MS20600B5-(1-2, 3-4, 5-6, 7-8)		9SP-B-B5-(1, 3, 5, 7)	
MS20600B6-(1-12)	CR157-6-(2-24)		RV250-6-(1-12)
MS20600B6-(1-2, 3-4, 5-6, 7-8, 9-10, 11-12)		9SP-B-B6-(1, 3, 5, 7, 9, 11)	
MS20600B8-(3-14)	CR157-8-(6-28)		RV250-8-(3-14)
MS20600B8-(3-4, 5-6, 7-8, 9-10, 11-12, 13-14)		9SP-B-B8-(3, 5, 7, 9, 11, 13)	
MS20601B4-(1-6)	CR156-4-(2-12)		RV251-4-(1-6)
MS20601B4-(1-2, 3-4, 5-6)		9SP-100-B4-(1, 3, 5)	
MS20601B5-(2-8)	CR156-5-(4-16)		RV251-5-(2-8)
MS20601B5-(2, 3-4, 5-6, 7-8)		9SP-100-B5-(1, 3, 5, 7)	
MS20601B6-(2-12)	CR156-6-(4-24)		RV251-6-(2-12)
MS20601B6-(2, 3-4, 5-6, 7-8, 9-10, 11-12)		9SP-100-B6-(1, 3, 5, 7, 9, 11)	
MS20601B8-(3-4, 5-6, 7-8, 9-10, 11-12, 13-14)		9SP-100-B8-(3, 5, 7, 9, 11, 13)	
MS20601B8-(3-14)	CR156-8-(6-28)		RV251-8-(3-14)



EXPLOSIVE RIVETS

Du Pont Aircraft Blast-Free Explosive rivets are the only type of explosive rivets used in Convair aircraft. These fast-acting, one-piece fasteners resemble ordinary solid rivets; however, there is one important difference. . . extending the full length of the shaft of each rivet is a small centered cavity, which contains a minute explosive charge. When heat is applied to the head of the rivet by an electrically-heated rivet iron or by friction from a spinning tool, the charge explodes and forms a uniform barrel-shaped upset on the shank.

Blast-free explosive rivets are available in two head styles, protruding and countersunk, and two materials, 5056 aluminum alloy and L nickel. Both aluminum and nickel rivets are available in 1/8, 5/32, and 3/16-inch diameters, and aluminum rivets are also manufactured in ¼-inch diameter.

Special rivet irons for installing explosive rivets are manufactured by Du Pont. If a Du Pont iron is not available, explosive rivets may be upset by an ordinary soldering iron; however, this procedure is slow, it is not always satisfactory, and it is not recommended for maintenance bases where explosive rivets are used frequently.

Du Pont rivet irons are operated in the following manner:

1. Insert tip (protruding or countersunk type) of the proper size in the socket.

2. Plug in rivet iron and heat controller.

3. Allow time for the iron to reach a temperature hot enough to explode rivet. Do not operate at full setting unless a check test has been made. Voltage used for riveting should be between 105 and 115 volts.

4. Insert rivet in hole. Be sure it is properly seated. Tap if necessary.

5. Apply tip of iron with sufficient pressure to insure good contact. Keep tip perpendicular to, and centered on, the rivet head. Within 1½ to 6 seconds, the charge will fire, expanding the shank to fit the hole.

6. Remove iron immediately after the rivet expands. The Blast-Free Du Pont rivet produces a muffled sound which indicates proper expansion.

7. Spinning tools may be used to explode rivets. A special phenolic head is mounted on a steel shank and chucked into a drill motor. When the head is applied to the rivet, sufficient heat is generated by friction to explode the rivet.

PART NUMBER IDENTIFICATION
DU PONT EXPLOSIVE RIVETS

P 56S 134 -100 -4

- -4 — Nominal grip length in 1/100 inch.
- -100 — Head Style
  - 100 = countersunk
  - A = protruding
- 134 — Approximate shank diameter in 1/1000-inch increments.
- 56S — Material designation
  - 56S = 5056 alum. al.
  - N = L nickel
- P — Rivet type
  - P = Blast free

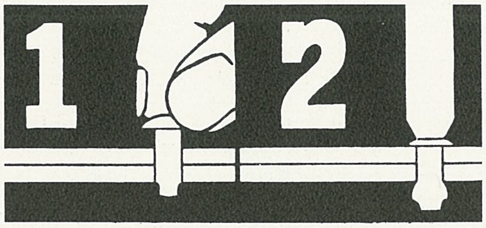
CAUTIONARY NOTES

Do not place rivets or boxes of rivets on steam radiators or on other hot objects.

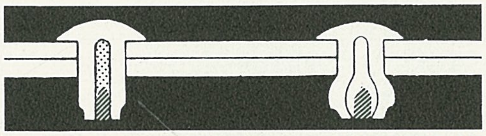
Do not use rivets which have been dropped if they are distorted or bent.

Do not throw unexpanded rivets in ordinary trash barrels. If they are distorted so that they cannot be used, place them in a screened basket and destroy them by placing basket in fire.

Do not expand rivets in the presence of inflammable gases or combustible dust. A structure containing gasoline vapors or other inflammable vapors should be blown with carbon dioxide or other inert gas before riveting is started.



EXPLOSIVE RIVETS ARE INSTALLED IN TWO SIMPLE STEPS:
1) INSERT RIVET 2) APPLY RIVET IRON TO HEAD.



A BLAST-FREE EXPLOSIVE RIVET BEFORE AND AFTER EXPANSION.

DU PONT BLAST-FREE EXPLOSIVE RIVETS

RECOMMENDED DRILL AND HOLE SIZES

Rivet Diameter	Drill Size		Finish Hole Size	
	Pilot	Finish	Min	Max
1/8	#30	#29	.135	.139
5/32	#22	#17	.172	.176
3/16	#12	#6	.203	.207
1/4	#1	#H	.264	.268

DU PONT 5056 ALUMINUM EXPLOSIVE RIVETS

GRIP LENGTH*

Rivet Diameter	Grip Range		Color	Part Number
	Min.	Max		
1/8	.005	.045	Yellow	P56S-134A-4
	.045	.085	Red	P56S-134A-8
	.085	.125	Brown	P56S-134A-12
	.125	.165	Black	P56S-134A-16
	.165	.205	Blue	P56S-134A-20
	.205	.245	Yellow	P56S-134A-24
	.245	.285	Red	P56S-134A-28
	.285	.325	Brown	P56S-134A-32
5/32	.025	.085	Red	P56S-173A-8
	.085	.145	Yellow	P56S-173A-14
	.145	.205	Blue	P56S-173A-20
	.205	.265	Black	P56S-173A-26
	.265	.325	Brown	P56S-173A-32
3/16	.025	.105	Blue	P56S-204A-10
	.085	.165	Black	P56S-204A-16
	.165	.245	Yellow	P56S-204A-24
	.245	.325	Brown	P56S-204A-32
	.325	.405	Blue	P56S-204A-40
1/4	.025	.105	Blue	P56S-263A-10
	.085	.165	Black	P56S-263A-16
	.165	.245	Yellow	P56S-263A-24
	.245	.325	Brown	P56S-263A-32
	.325	.405	Blue	P56S-263A-40

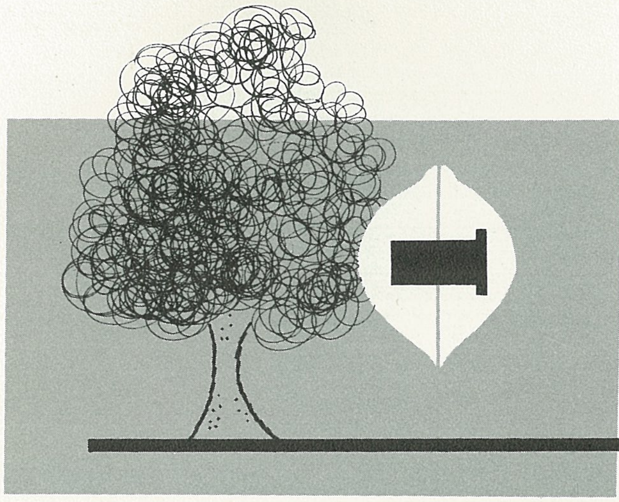
*Grip lengths shown are for protruding head rivets. The same sizes are available in countersunk rivets.

DU PONT L NICKEL EXPLOSIVE RIVETS

GRIP LENGTH*

Rivet Diameter	Grip Range		Part Number
	Min.	Max	
1/8	.010	.072	PN-134Ax1/16
	.073	.134	PN-134Ax1/8
	.135	.197	PN-134Ax3/16
	.197	.259	PN-134Ax1/4
5/32	.010	.072	PN-173Ax1/16
	.010	.134	PN-173Ax1/8
	.073	.197	PN-173Ax3/16
	.135	.259	PN-173Ax1/4
3/16	.010	.072	PN-204Ax1/16
	.010	.134	PN-204Ax1/8
	.073	.197	PN-204Ax3/16
	.135	.259	PN-204Ax1/4

*Grip lengths shown are for protruding head rivets. The same sizes are available in countersunk rivets.



RIVNUTS

Rivnuts are one-piece, internally-threaded, tubular rivets which may be used as blind nutplates, blind rivets, or as a combination of both.

They are frequently used to attach brackets, instruments, trim materials, and lightly loaded fittings which are attached to the structure after the assembly has been completed.

At the present time, Rivnuts, which are manufactured by the B. F. Goodrich Company, are available in aluminum alloy, cadmium-plated steel, and brass.

After Rivnuts are installed, accessories can be fastened securely in place with screws and they can be removed easily. This makes the Rivnut particularly valuable for the attachment of parts requiring frequent maintenance or checks.

One particular advantage of this type of blind rivet is that the method used in its installation exerts no other force than compression on the materials joined. There is no tendency of the material to split.

The flat-head and countersunk types may be obtained with a key beneath the head to take the torque imposed on the Rivnut when it is used as a nutplate; however, the use of a key-type Rivnut necessitates notching a keyway in the material, which may not be desirable on structural parts.

When Rivnuts are used as rivets, shear strength may be materially increased by the insertion of a suitable screw in the Rivnut after installation.

Part numbers indicate material, thread size, key or keyless, open or closed end, and maximum grip. Head style is not indicated in Rivnut part numbers.

Rivnuts should be installed only if designated on the engineering drawing or if special permission is received.

The following conditions must be observed:

1. There must be adequate clearance for the Rivnut underneath the material before it is drawn up.

2. The grip must be determined and a proper Rivnut selected, according to the thickness range and the corresponding radial mark. Certain sizes of Rivnuts have radial marks on the head to indicate the grip range. Those without radial marks have type numbers stamped on the head.

3. For all types of Rivnuts, a small hole must be drilled, then enlarged with the correct drill to the required diameter. The hole must be a snug push fit. A tight hole which will scrape off the anodic coating or cadmium plating must be avoided. Enlarged holes are undesirable and produce a faulty installation.

Rivnuts are made with and without a key. If the Rivnut is the key type, it is necessary to cut a key slot in the sheet prior to installation. Keyways are cut with a B. F. Goodrich key seater. To cut keyways in metal too thick for this tool, a special guide drill bushing should be used. Only the rivet type specified on the engineering drawing should be used, because a keyway could weaken certain sections of the structure.

PART NUMBER IDENTIFICATION
RIVNUTS

A 8 - 201

- 201 — Maximum grip in .000 inch
- - — Type
  - - = open end, no key
  - B = closed end, no key
  - K = open end with key
  - KB = closed end with key
- 8 — Internal threads or screw size in 32nds.
- A — Material
  - A = 6053-T4 al. al. anodized
  - S = C1108 steel cad-plate
  - BR = 66-34 brass

Rivnuts are inserted and headed with a special tool manufactured by the B. F. Goodrich Company. The heading tool engages the rivet and transmits a pull on the threaded portion until the counterbore (which is thinner) bulges, the expanding metal seating itself firmly against the material.

The B. F. Goodrich rivet gun is used as follows:

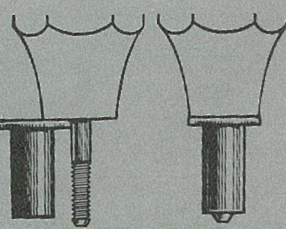
1. Thread Rivnut on pull-up stud until head bears against the anvil of the tool.

2. Insert Rivnut in hole. When using key type Rivnut, be sure that key lines up with keyway.

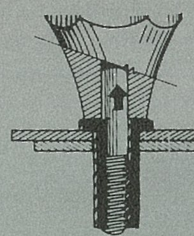
3. With tool held at right angles to the work, close handle until solid resistance is felt. Do not force handle further; otherwise, threads may be stripped or the mandrel may break.

4. Disengage pull-up stud, and make attachment as required. An AN936 washer is required under the head of all screws unless other means of locking are provided.

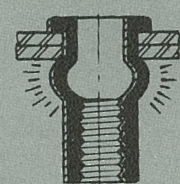
To remove an installed Rivnut, drill out by using the same size drill as that used for the original hole. Since the Rivnut is hollow, it will guide the drill throughout the operation. The same size Rivnut can be installed in the same hole, if desired.



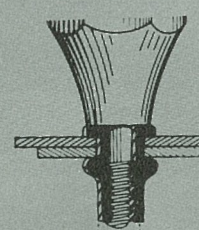
THE TAPERED POINT OF THE PULL-UP STUD SHOULD EXTEND JUST BEYOND THE END OF THE OPEN-END RIVNUT.



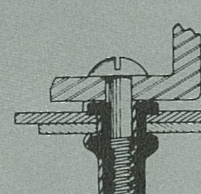
HEADING TOOL TRANSMITS PULL ON THREADED PORTION.



A BULGE FORMS AT COUNTERBORED PORTION, WHICH IS THINNER.



METAL EXPANDS AND SEATS FIRMLY AGAINST MATERIAL.



PULL-UP STUD IS THEN REMOVED AND RIVNUT IS READY FOR ATTACHMENT OF OTHER ITEMS BY MEANS OF A SCREW.

COUNTERSUNK RIVNUTS

WITHOUT KEY*

PART NUMBER	DRILL SIZE PILOT	DRILL SIZE FINISH	THREAD	GRIP RANGE MIN	GRIP RANGE MAX
A4-81	#29	5/32	4-40	.051	.081
A4-106				.081	.106
A4-131				.106	.131
A6-106	#19	#12	6-32	.065	.106
A6-161				.106	.161
A6-201				.161	.201
A8-106	#8	#2	8-32	.065	.106
A8-161				.106	.161
A8-201				.161	.201
A10-136	#1	#E	10-32	.065	.136
A10-201				.136	.201
A10-261				.201	.261
A25-151	N	Q	1/4-20	.089	.151
A25-211				.151	.211
A25-271				.211	.271
A31-181	3/8	Z	5/16-18	.106	.181
A31-256				.181	.256
A31-331				.256	.331
A37-211		12.5 mm	3/8-16	.125	.211
A37-296				.211	.296
A37-381				.296	.381
A50-276		41/64	1/2-13	.156	.276
A50-396				.276	.396
A50-516				.396	.516

PROTRUDING HEAD RIVNUTS

WITHOUT KEY*

RIVNUT NUMBER	DRILL SIZE PILOT	DRILL SIZE FINISH	THREAD	GRIP RANGE MIN	GRIP RANGE MAX
A4-60	#29	5/32	4-40	.010	.060
A4-85				.060	.085
A4-110				.085	.110
A6-75	#19	#12	6-32	.010	.075
A6-120				.075	.120
A6-160				.120	.160
A8-75	#8	#2	8-32	.010	.075
A8-120				.075	.120
A8-160				.120	.160
A10-75	#1	E	10-32	.010	.075
A10-140				.075	.140
A10-190				.140	.190
A25-80	N	Q	1/4-20	.020	.080
A25-140				.080	.140
A25-200				.140	.200
A31-125	3/8	Z	5/16-18	.050	.125
A31-200				.125	.200
A31-275				.200	.275
A37-115		12.5 mm	3/8-16	.030	.115
A37-200				.115	.200
A37-285				.200	.285
A50-145		41/64	1/2-13	.025	.145
A50-265				.145	.265
A50-385				.265	.385

COUNTERSUNK RIVNUTS

WITH KEY*

PART NUMBER	THREAD	GRIP LENGTH MIN	GRIP LENGTH MAX
A6K106	6-32	.065	.106
A6K161		.106	.161
A6K201		.161	.201
A8K106	8-32	.065	.106
A8K161		.106	.161
A8K201		.161	.201
A10K136	10-32	.065	.136
A10K201		.136	.201
A10K261		.201	.261

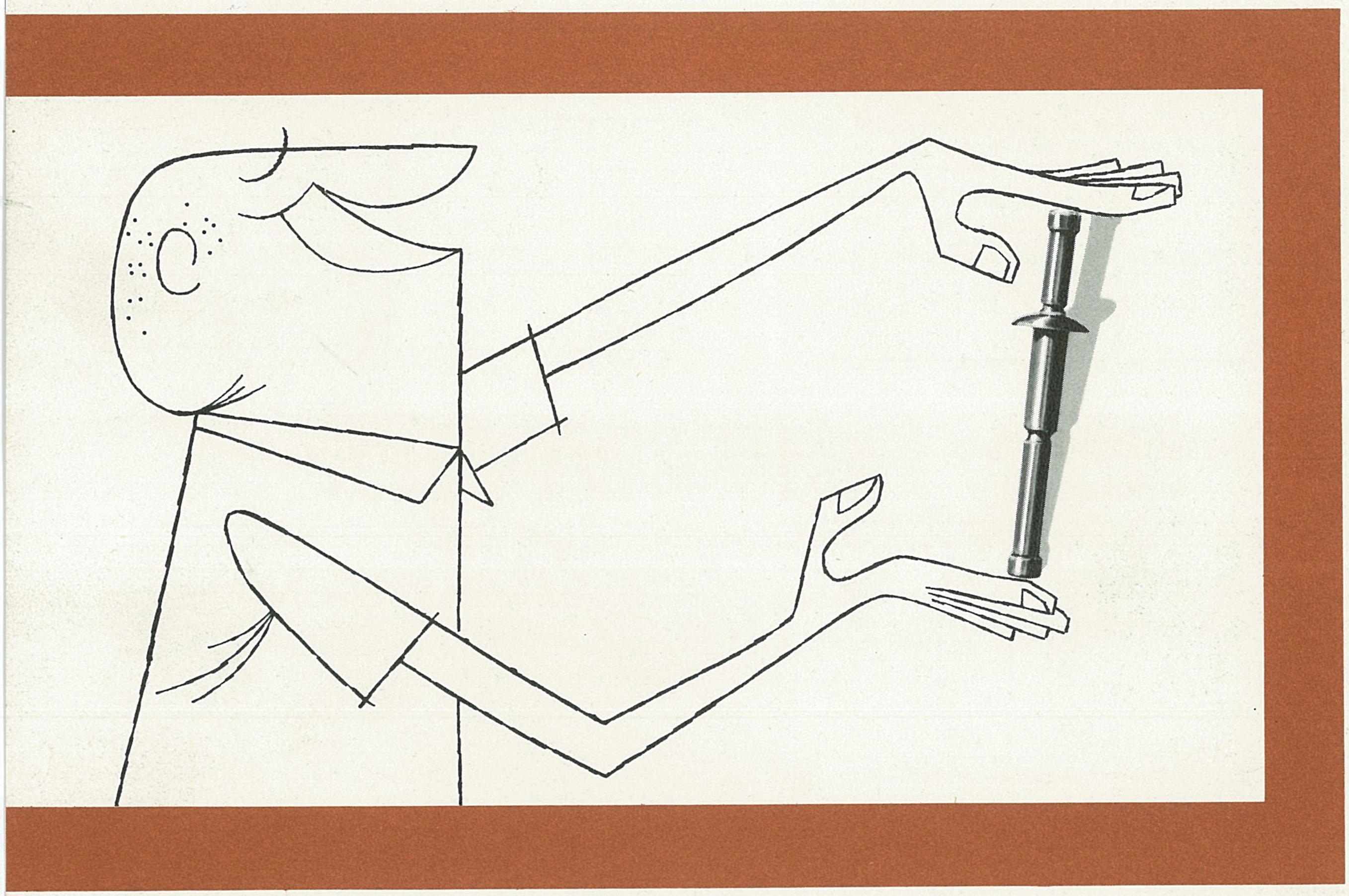
*All Rivnuts shown are 6053-T4 aluminum. The same grip ranges are available in other materials.

PROTRUDING HEAD RIVNUTS

WITH KEY*

PART NUMBER	THREAD	GRIP RANGE MIN	GRIP RANGE MAX
A6K75	6-32	.010	.075
A6K120		.075	.120
A6K160		.120	.160
A8K75	8-32	.010	.075
A8K120		.075	.120
A8K160		.120	.160
A10K75	10-32	.010	.075
A10K140		.075	.140
A10K190		.140	.190

*All Rivnuts shown are 6053-T4 aluminum. The same grip ranges are available in other materials.



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CONVAIR Traveler

VOLUME VIII NUMBER 8 DECEMBER 1956

CONVAIR *Traveler*

VOLUME VIII NUMBER 8 DECEMBER 1956

FOREWORD

The higher operating speeds and increased size of today's aircraft necessitate an increase in the number of instruments and indicators. Although jet aircraft require less instruments and controls than do present piston-powered aircraft, their higher operating speeds reduce the time allowed for crew interpretation and reaction. As greater demands are made on the pilot's discriminative capacities, it becomes necessary to take special precautions to avoid the accidental use of one control or placard for another. Therefore, the design engineer must be advised that the more distinctive visual, tactical, or kinesthetic cues that can be built into controls, the fewer will be the errors of confusion.

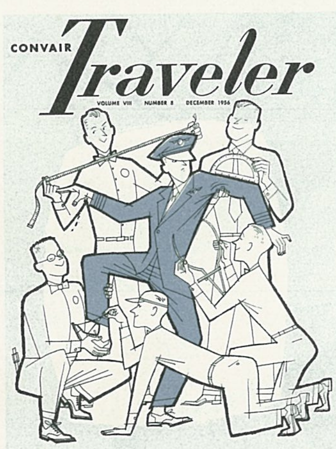
To assist the design engineer, Convair has recently established a Human Engineering Group . . . an advisory group . . . to give design engineers complete quantitative data on human performance as a function of all important factors in aircraft design.

Since the human element in design involves many ramifications, only those design features initiated and/or proved by Convair in the design of cockpits in commercial aircraft are discussed herein.

ON THE COVER

The hypothetical pilot is registering traditional male impatience at being measured and fitted. He's really not unhappy, though, because if you'll look closely you'll see that the busy 'tailors' are armed with slide rules, calipers, and protractors. They are not fitting him to a suit but to an airplane! The better this 'fit' is, the happier and more efficient the pilot will be.

The artist — Ken Martin



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the HUMAN ELEMENT
in design of Convair-Liner Cockpits

When man built his first flying machine, he was concerned only with getting his contraption up in the air. Hanging on and controlling it in flight were somewhat incidental, since he had to solve a lot of other problems at the same time. The location of his control levers, which he aptly called sticks, was decided more by the mechanical expediencies of the flying machine's structure than by whether he could reach them easily and efficiently from his open-air seat in front of the lower wing's leading edge.

Later, he enclosed the fuselage. But this was for aerodynamic reasons — not for personal comfort or other human considerations. In fact, wiggling into the seat was such an experience that the expressive airman dubbed this compartment appropriately, "the cockpit." Crawling into those early machines was certainly as hazardous to the shins as crawling into a pit with a pair of fighting roosters . . . so the name stuck.

In those early airplanes, designers combined related control surfaces with lateral and vertical systems, thus simplifying the number and arrangements of gadgets in the cockpit. Visibility was poor and sometimes the pilot had trouble deciding which way was up, so he kept a partially filled bottle in his lap as an improvised spirit level. Later he hung a plumb bob on the structure in front of him. The need for indication provided by these two devices prompted design of the "needle ball" instrument, which is still found in modern aircraft and is one of the most important "basic flight instruments."

Later, he added a re-graduated barometer (differentiated as an altimeter), and the instrument panel became an accomplished fact.

From that time to this, the pilot has needed more controls for the increasingly complex airplane . . he has needed better means of sensing the conditions of the various parts of the airplane as well as methods for determining his attitude when visual contact with reference objects was lost.

And so, consideration of the human element in cockpit design has become an increasingly important factor.

While great strides have been made in aircraft design and in the study of the relationship of man to machine since those early flying machines, relatively little progress has been made in application of this relationship study. With more and more pilots flying more hours in commercial aircraft, any discrepancies in this relationship become apparent in the form of pilot complaints regarding his operational tools. Many "error" accidents may have had their origin in the design of the unit, thus the need for greater consideration of the man-machine relationship.

General principles in cockpit design have been formulated by the Civil Aeronautics Board and these rules and regulations have become standard practice for Civil Air transports.

Although these Civil Air Regulations serve a definite purpose in transports now in service, the high speeds and maneuverability of jet aircraft require a fresh evaluation of these regulations. The experimental data being gathered must be studied and implemented with quantitative data and general design principles to replace those precepts which may have been a result of early experience.

During the design stage of the Convair 240, on the threshold of Convair's entry into the commercial transport field, design engineers studied recommendations submitted by airline pilots and engineers in an effort to standardize cockpit panel arrangement in all transport category aircraft. This marked a new era in the design of commercial transports since pilots were consulted in regard to the location and arrangement of controls and instruments.

Together with Convair engineers they sought to design a flight deck that would establish an entirely new concept in flying efficiency and pilot comfort and convenience. Along with improvements, Convair designers were committed to create a panel arrangement that would be generally similar to that in other existing two-engine equipment, so that pilot confusion in the transition from one aircraft to another could be minimized.

While standardization is an important factor, too much emphasis on this particular phase of design has a tendency to hamper progress. The ever-changing demands of modern air travel continue to call for a new approach, new ideas, and the continued application of proved ideas.

In designing the cockpit, one of the design engineer's chief concerns was in the arrangement of instruments on the panel . . . an arrangement that would tend to minimize the opportunity for human error.

In Convair-Liner aircraft, engine instruments are grouped on the center panel; identical flight instruments are located as to function on the panels in front of the pilot and copilot; instruments and controls for fire are located for use and operation by either pilot. Grouped according to function are circuit breakers and fuses, insofar as is practicable, for easy sequential reading and quick deenergization of circuitry. Such groupings, recommended by the design engineer with the human factor in mind, tend to minimize pilot fatigue and error.

Immediate popularity of the Convair-Liner 240 in ease and efficiency of performance was due in no little measure to this pioneering of systematic arrangement of pilot facilities. This consideration of the human element in design has firmly convinced the aviation world of the importance of an organized approach to the human factor in airplane design.

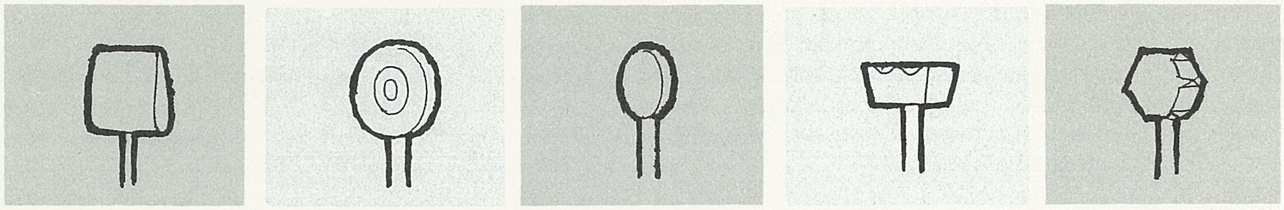
To assist in the man-machine relationship, many special methods and devices have been designed with the pilot in mind. These, at the proper time, warn the pilot of necessary operations, prevent inadvertent use of controls, and give warning of, or actually rectify a dangerous condition.

Among warning devices on Convair-Liner aircraft are the fire detector and warning systems. Red lights on the fire control panel light to indicate fire location, and a bell rings intermittently to call the pilot's attention to the panel.

A temperature switch automatically opens augmentor vanes when temperature at the heat source valves reaches $660 \pm 25°F$, and a steady ring of the bell warns the pilot of this condition.

If landing gear is not down when the pilot is coming in for a landing, a horn will sound to so indicate. The landing gear warning horn functions with an interrupted sound if flaps are not down and the throttles are advanced for takeoff power.

Another system that eliminates the necessity for constant monitoring is the NESA glass windshield installation. Thermal protection against icing and fogging of the windshield is provided by an electrically-heated transparent conductive vinyl layer buried in the construction of the heavy safety glass. Multiple tap transformers are installed so that pilots can select the desired voltage to be applied to the glass. Temperature sensing elements of the wire-grid type, imbedded in the vinyl layer of the glass assembly, operate to maintain the glass at a minimum temperature of 28.3°C (83°F). At approximately 35°C (95°F), the power to the glass is automatically



Flap Control | **Landing Gear Control** | **Throttle Control** | **RPM Control** | **Mixture Control**

Control Knob Shapes as Standarized by CAB

turned off to prevent damage from overloading. The system thus contains its own "brain," and makes no additional demands on that of the pilot.

An important safety factor that reduces the fixation time necessary for accurate reading is the power-failure warning indicator which immediately indicates even a partial power failure of the flight instruments for both the pilot and copilot. Under normal power conditions, a cup-shaped drum, half of which is black and the other half fluorescent, will show only the black half. If a power failure occurs, the fluorescent half becomes visible. The degree to which it becomes visible depends upon the degree of failure. If one phase of the applied voltage fails, or if the voltage on all three phases falls below 18 volts, the fluorescent half of the drum becomes entirely visible.

Radial lines and arcs on some instruments readily indicate an operating condition. Three basic colors are used: red for the danger zone, or outside safe operating limits; yellow for caution, or careful monitoring; and green for satisfactory operation within limits.

Much time and effort are being expended in the study of panel lighting, but many factors other than light source and intensity, and weight and size of lighting units must be considered. Red and white rheostat-controlled lighting is used for panel lighting on present Convair-Liner aircraft. The brightness level of the panel lighting is automatically dimmed to assure proper intensity under fading outside light conditions whenever navigation lights are turned on. The overhead switch panel is lighted by red and white spot lights, which are installed aft of the pilots' positions.

Proper seat design assists pilots in reaching operating controls and equipment more easily. The pilot's seat on Convair-Liner aircraft, being adjustable both horizontally and vertically, serves as a physiological "equalizer" to meet the requirements of pilots ranging in size from 5'10" to 6'2. Although flying is not usually thought of as a sedentary occupation, pilots do spend a lot of time in the chair. To provide efficient fatigue-free operation, seats must be properly cushioned to evenly distribute body weight.

The only phase of cockpit design in which standardization is stressed is in the design and mechanical positioning of controls. Controls are located so that the pilot can operate them without confusion and in a manner tending to prevent inadvertent operation.

Positioning, or direction of movement, of controls is established by the Civil Aeronautics Board and is a part of Civil Air Regulations. The CAB requires that such controls as Fuel Tank Selector Valves, Wing Flap and Landing Gear Position Indicators, etc., be designed to render improbable their inadvertent operation. On the wing flap, for example, the control is so designed to permit the pilot to select flap positions for takeoff, enroute, approach, and landing, and to maintain any of these positions without further attention.

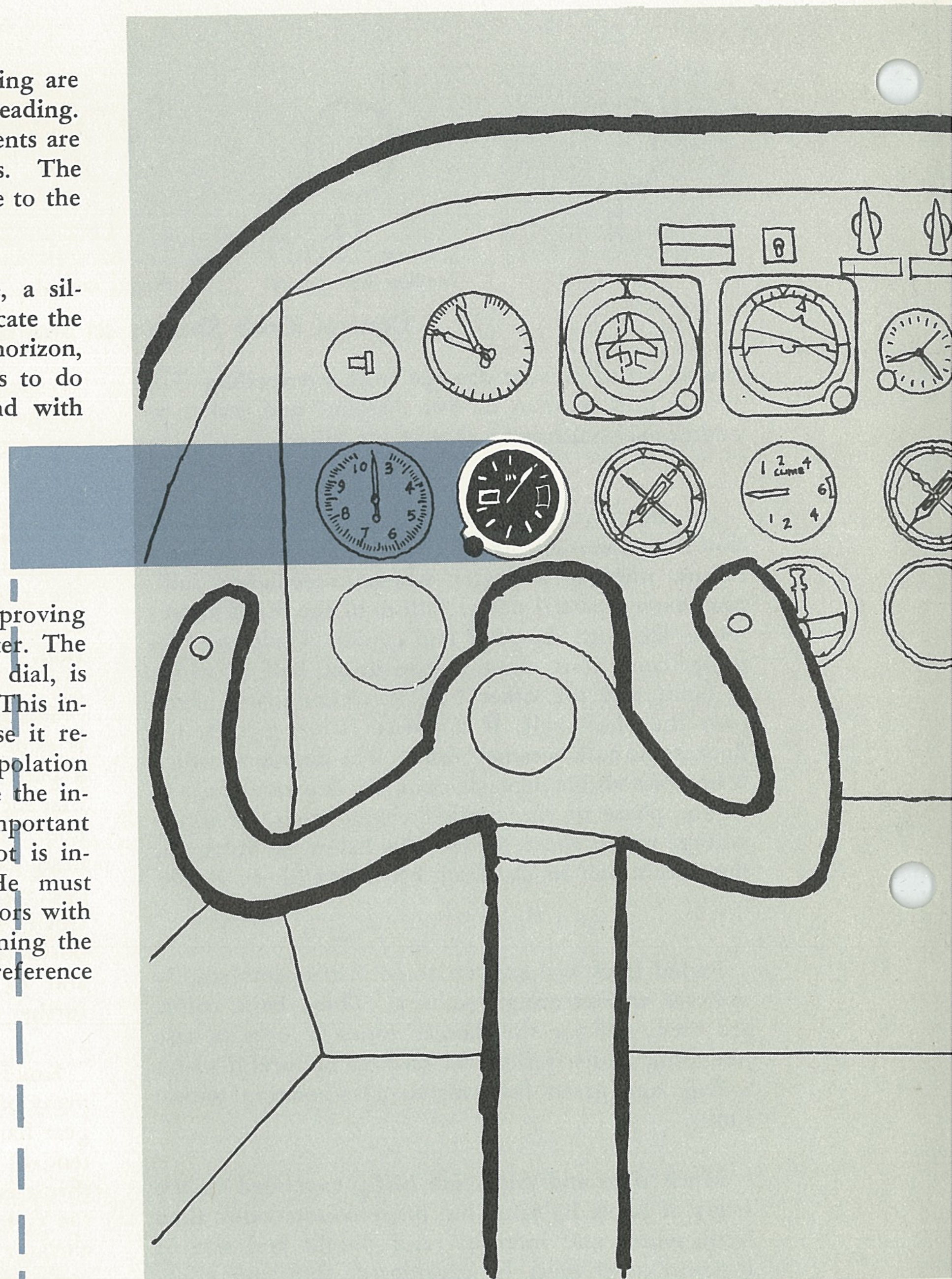
Kinesthetic "cues" are required in the design of many of the controls. For example, when the landing gear handle is moved down, the gear is down, or extended; when throttles are moved forward, forward thrust is increased; when aileron control is turned to the right, or clockwise, the right wing will lower; if elevator control is moved rearward, the nose will come up; and trim tab controls are rotated to produce similiar rotation of the airplane about an axis, parallel to the axis of the control.

Tactile cues required on control knob shapes for landing gear, flap, and power plant have been recently standardized by the Civil Aeronautics Board; thus, the pilot on transport aircraft will learn to associate each type of knob with a certain type of control.

The designing of distinctive features into controls requires considerably more research and study for today's high-speed aircraft, because as more automatic devices are used and as operational characteristics of aircraft change, more distinctive visual, tactile, and kinesthetic cues will be required to eliminate errors of confusion.

Instruments that require simple check reading are preferred over those that require quantitative reading. Two good examples of check-reading instruments are the rate-of-climb and airspeed indicators. The "pointers" on these instruments directly relate to the type of information displayed.

On some attitude indicators, for example, a silhouette of an airplane and a horizon bar indicate the relationship of the actual airplane to the horizon, or level flight. So, in effect, all the pilot has to do is "fly" the miniature airplane to correspond with the bar on the dial.



An example of Convair's interest in improving instrumentation is in the case of the altimeter. The present altimeter, which has a three-pointer dial, is particularly susceptible to errors in reading. This instrument cannot be read at a glance, because it requires some five to seven seconds for interpolation . . . the combining into one numerical value the indications of the three pointers. During an important phase of flight — the approach — the pilot is involved in many details of importance. He must coordinate airspeed and gyro horizon indicators with the altimeter reading, at the same time aligning the airplane with the runway (visually or with reference to ILS).

Instrument and panel c

Convair 880

Consideration of th

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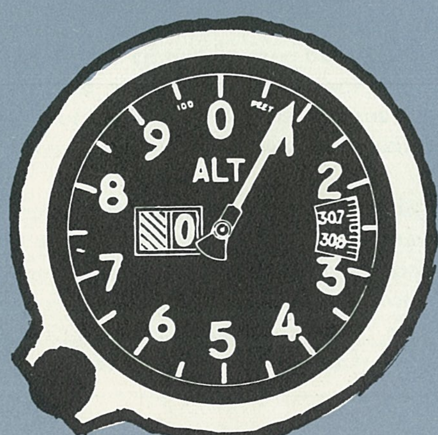
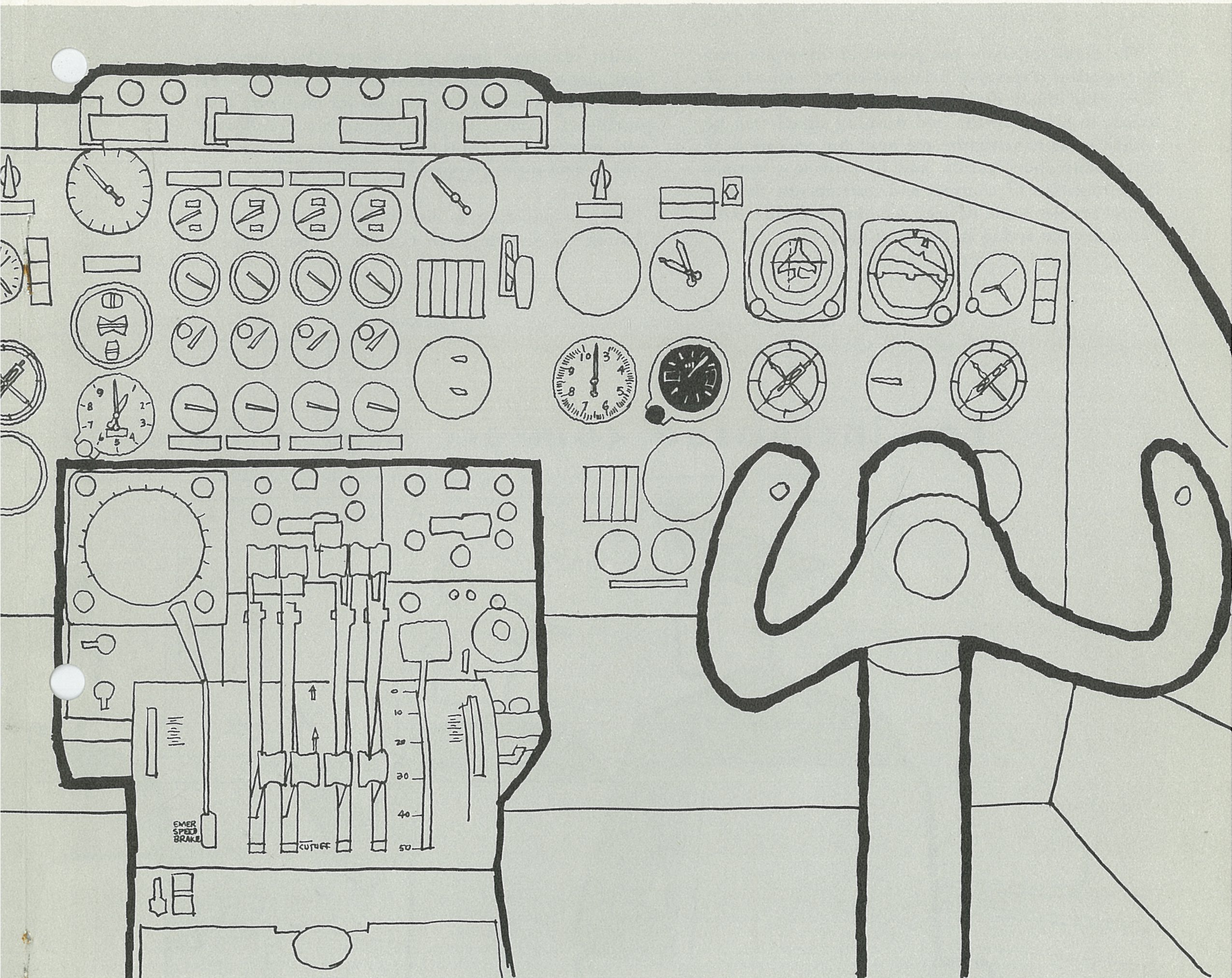
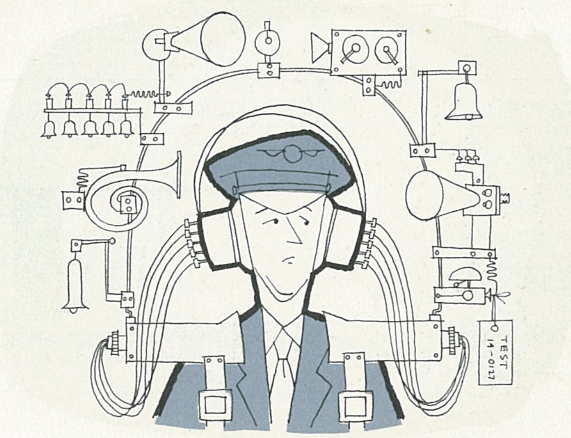


A new altimeter developed by the Air Force will be used on the Convair 880. The altimeter will use a sensitive pointer and a counter. The counter gives altitude in thousands of feet; the pointer adds the hundreds. Tests have shown that this new instrument cannot only be read faster, but with greater accuracy.



arrangement to fit the pilot

he human element in instrument and panel design is indicated by the many new features incorporated he Convair 880 with the pilot in mind.



The flight simulator has played an important part in replacing expensive trial-and-error methods of developing flight decks in new aircraft. Pilots' reactions to safety devices and warning signals can be studied so as to recognize the need for relocation of instruments and controls, and to provide a certain standardization of controls and instruments. Experimental problems and devices, too, can be studied with a considerable saving in time and money.

Pilot reactions, measured and recorded, present a clear picture of the pilot's mastery of the airplane, and provide a satisfactory method for analyzing pilot procedures under varying emergency conditions. And, it presents a means of studying these procedures with a view toward improving cockpit design.

Flight simulators in use today are, in a sense, "human engineering laboratories." They test the

For increased comfort and efficiency

Reading from left to right: observer, pilot, co-pilot, flight engineer.

Note extra large windows which give an exceptionally wide range of vision. Windows incorporate thermal protection against icing and clouding.

pilot's reaction to sound, signals, and instrument pointer movement, and determine his perceptive abilities, judgment, and selective recall. But, more than that, they double for the actual aircraft in familiarization and proficiency training of flight crews, and duplicate in exact detail all flight operational installations and performance features.

The flight simulator can, with sometimes alarming realism, simulate performance of the actual aircraft under all conditions of flight, including one engine out, propeller windmilling or feathering, landing gear retraction or extension, wing flap position, cowl flap position, altitude, attitude, normal and one-engine takeoffs and landings, reversible propellers and many others.

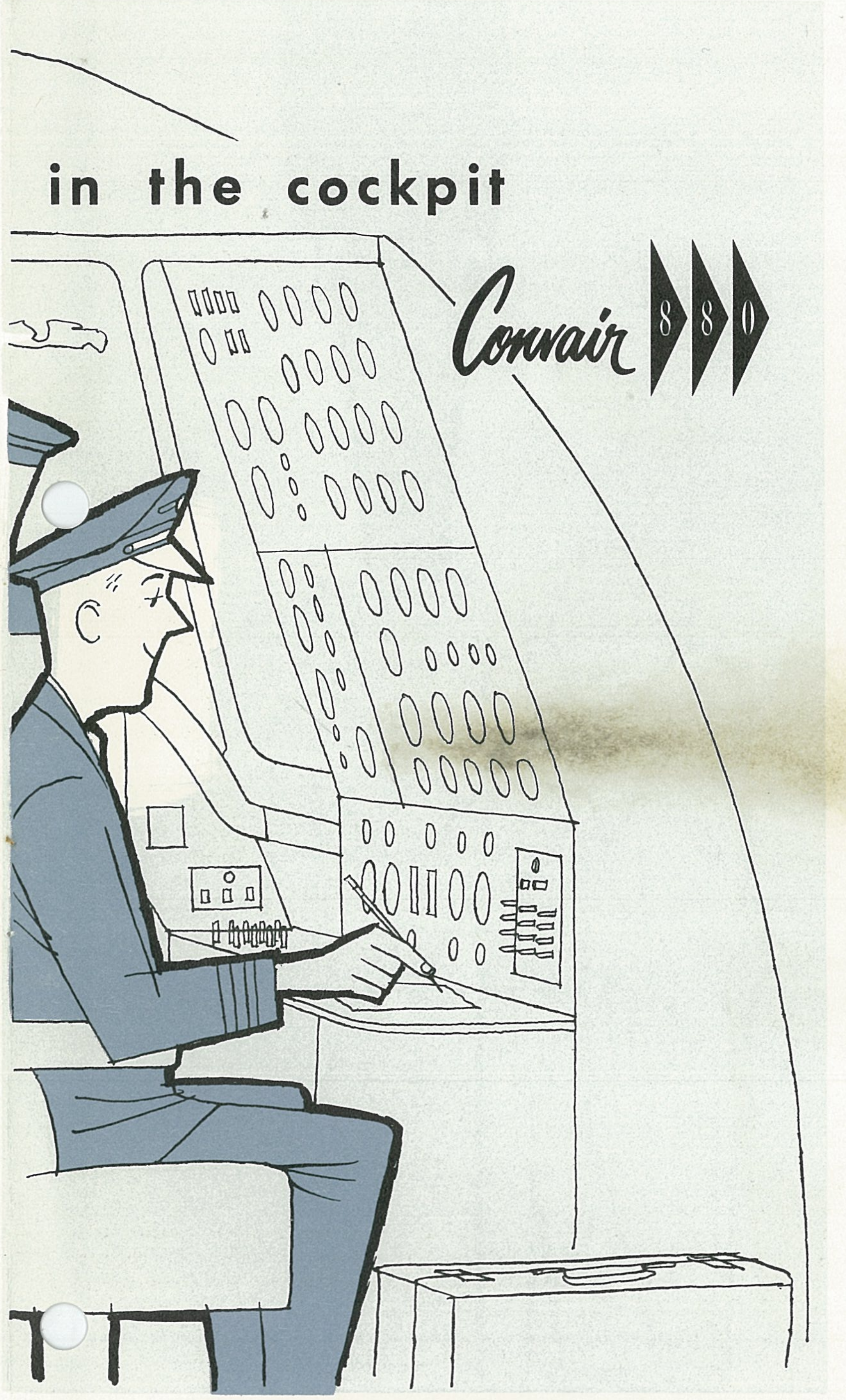
Flight simulators save many hours of actual flying time and aircraft operational expense but, more important, they can simulate certain emergency procedures — many of which can be obtained only in a simulator.

Such emergency procedures as are necessary during engine fire, failure of landing gear to extend or retract, etc., are awkward or impossible to enact in an actual aircraft, but in the flight simulator they can be practiced repeatedly until the pilot can perform them in an effortless confident manner. Then, too, there are those simulated emergency or adverse conditions that require action . . . oil and fuel pressure low, carburetor ice, wing icing, reduced BHP, abnormal carburetor air and cylinder head temperatures, too lean or too rich a mixture, hydraulic system failure, tail buffet, and many other conditions and combinations of these.

The factor of an individual's reaction to an *actual* emergency is missing in simulator training; however, mechanical reactions obtained from repeated practice of emergency procedures are the best insurance to reduce the confusion generated by some emergency situations.

"Pilot error" is blamed for a large percentage of aircraft accidents, but the phrase itself provides no information relative to the actual cause of the accident. To analyze causes of some of these "pilot error" accidents, it has been necessary to study and consider his reactions under environmental conditions or situations which may have existed at the time of the mishap, and to analyze the performance capabilities of the pilot at takeoff and, more important, long after takeoff. The design engineer is interested in *what* caused the accident . . . the human engineer is interested in *why* the accident was caused.

Human Engineering, a study of the use of man's capabilities and limitations in the accomplishment of a job, is becoming increasingly important in the aircraft industry with the higher operating speeds and increased size of today's commercial aircraft. Human Engineering is an application of information about man's muscular coordination, his sensory capacities, and his powers of reasoning, judgment, and comprehension. It is an evaluation of the speed and accuracy of the human machine in responding



to various tasks under varying operating conditions of lighting, strain, stress, and noise. It is designed for the comfort and safety of the human machine—the elimination of confusion and accident-inducing hazards—and involves the successful interpretation of results for practical applications.

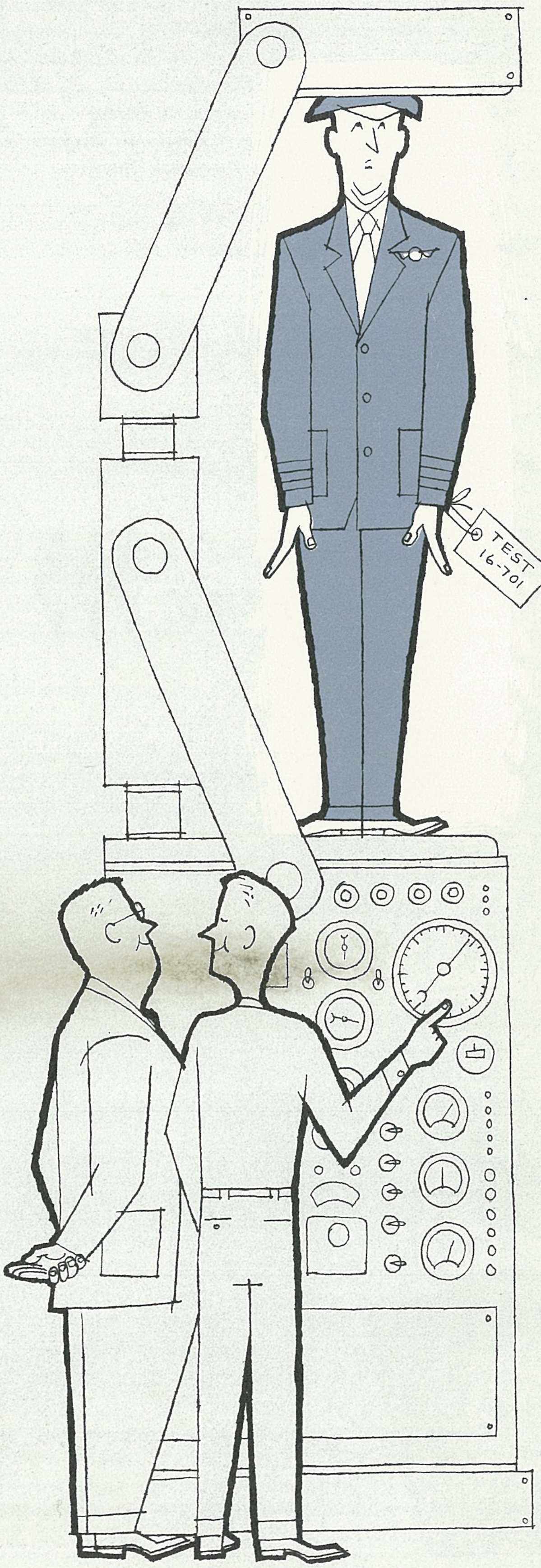
Since millions of hours are spent annually in designing aircraft, the design hours spent in insuring their efficient operation by the human machine must also be many if we are to increase the effectiveness of the man-machine combination. All attempts to redesign the human machine have failed so it becomes necessary for the design engineer to enter into his equations the complex factor representing the human element.

Although Human Engineering is a relatively recent development, its principles and precepts have been in existence almost as long as the human race itself. The prior employment of these precepts could be classified as the employment of educated common sense in design, or just plain "horse sense." When employed successfully, the result is good design.

Human Engineering in its complete scope embraces the teachings of many sciences—no one science having a proprietorship in this field. The Human Factors engineer must know something about anthropology, psychology, and physiology — to name a few—in addition to his engineering background if he is to design the machine for greatest efficiency.

Until recently, the sciences of physiology and psychology were largely concerned with the human sensory and response characteristics as related to the general fields of medicine and sociology. Today, these sciences are being taken off the academic shelf and are being put to work throughout the aviation industry in designing performance efficiency into the man-machine combination.

The anthropometrist, who traditionally studies the measurements of the human body in relation to the phenomena of growth, constitution, racial differentiation, and comparative primate anatomy is today adapting his theoretical knowledge to the very practical design of aircraft and equipment. The measurements he has compiled of the human body in various positions, and the pivotal action of the various joints are an important factor in the design of today's high-speed aircraft. However, the average body measurements and the relationship of the limbs to the rest of the body—figures compiled in the past—require



re-evaluation in the study of today's complicated machine, because the engineer needs dynamic information that can be applied specifically to the task at hand. Anthropometry in Human Engineering is used principally for making predictions. In designing equipment, typical body movements limited by work space, clothing, and equipment, must be studied to make the poor human being less clumsy, happier, and more efficient, all at the same time.

Physiology, a study of the organic processes of the body, takes a new approach when used in relation to aircraft. In this phase of study, the body is usually considered as a unit—the action of the internal organs being a function of external conditions—altitude, pressure, temperature, and acceleration. This science in the study of Human Engineering is essentially in its infancy since there is relatively little known about the mechanics of respiration, motor response· aero-embolism, circulation, and neuro-muscular coordination at the speeds, altitudes, and *g* loads experienced in modern supersonic aircraft.

Laboratories have been established throughout the country to study the effects of the new environment on man — an environment that affects not only the physiological reactions of man but the psychological results of fatigue, as well. By designing controls and displays that are compatible with man's physiological and psychological limitations, errors will be minimized and mental fatigue, resulting from long hours of mental concentration and strain, are lessened.

Since engineering methods and terms and the capabilities of an airplane are not understood by the physiologist and psychologist, and the psycho-physiologist's terms and the limiting factors of man are not known by the engineers, it becomes necessary to establish a new science — that of Human Engineering.

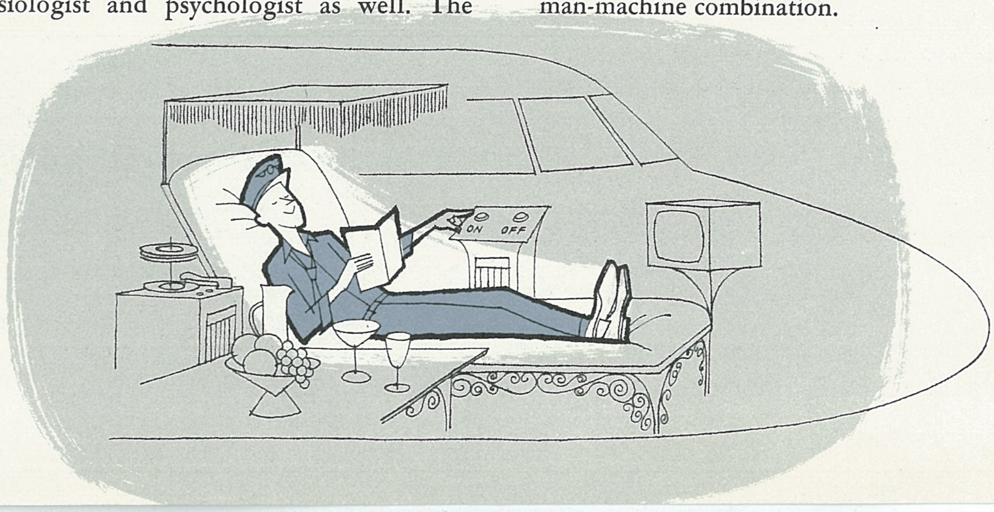
To this end, Convair has established a Human Engineering group to advise and aid other engineering groups in the design of equipment, controls, and facilities. This new field, which embraces many sciences, is useful not only to the design engineer but to the physiologist and psychologist as well. The human engineer requires a broad knowledge of the limits of human tolerance and capabilities, and must also understand the methods of design used by the engineer. It is he who must span the language barrier and thus combine the human and machine factors to solve the many problems of today's complex equipment.

The human engineer studies the many requirements of the pilot and strives to build proper sensory cues into the controls and displays — so that they are distinctive enough to minimize confusion. Of course, compromise due to structural requirements, size, and weight are sometimes necessary. Maintenance accessibility of the units must be considered if realistic panel design is to be accepted.

Although the foreseeable trend in military aircraft weapons seems to be in the direction of eliminating the pilot altogether, it seems rather doubtful if this will ever be the case with commercial aircraft. Any mechanical device can malfunction and, when it does, it is comforting to have a supply of good human judgment aboard to fill the gap. The 21st century counterpart of our airline captain may be called a Systems Monitor, but he'll still be there.

The mechanical machine, no matter how complicated, can function only within prescribed limits determined by design and the capabilities of control by the human machine. The human machine, on the other hand, can function only within certain tolerances. The proof of this pudding can be seen by comparing the number of people who have at times expressed a desire for a third hand, to the number of people who have succeeded in growing one. It is the realm of the human engineer to face this innate stubborness of human physiology, take the gadget that requires three hands to operate, and eliminate the need for the extra hand.

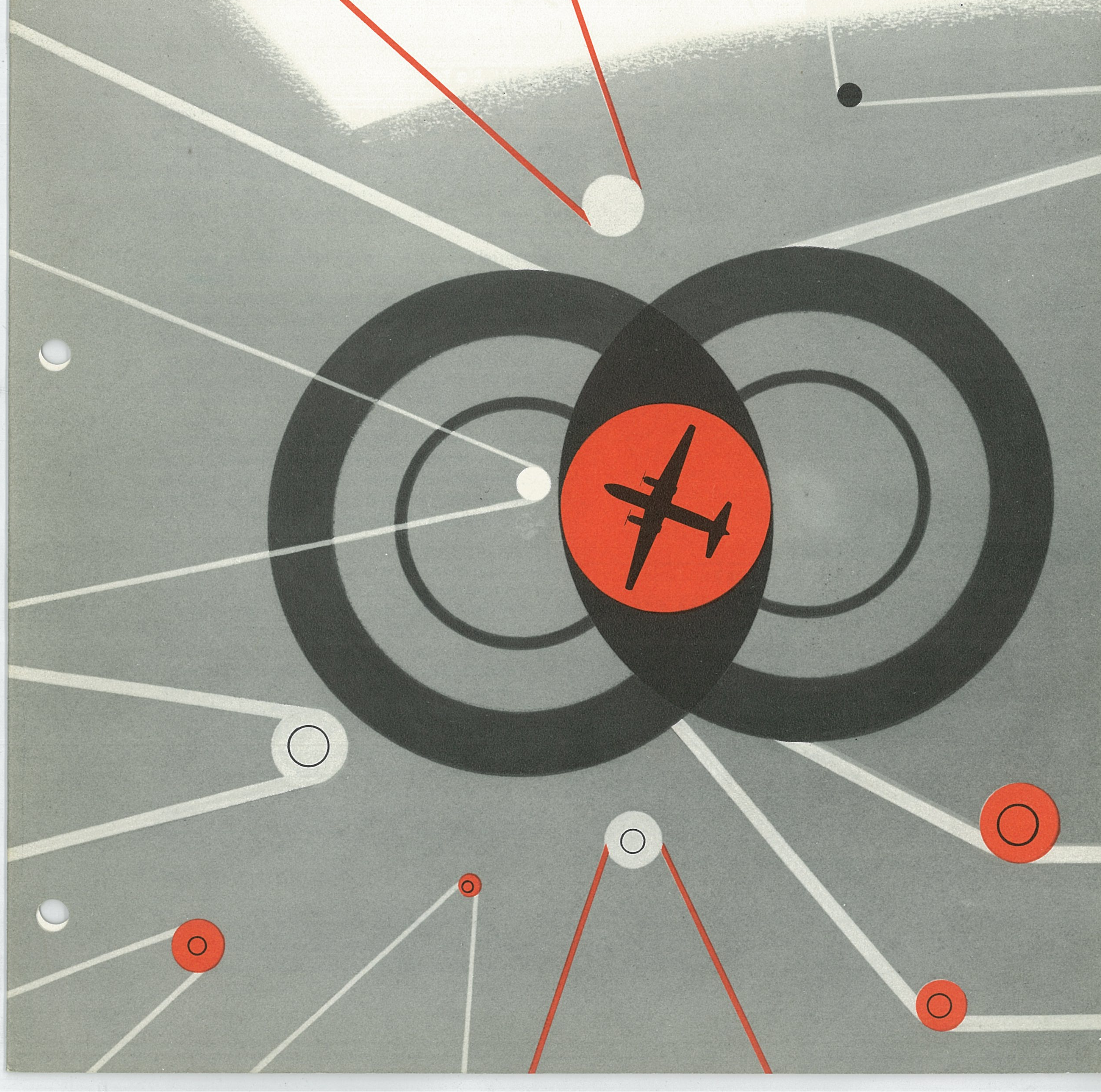
Although research to date represents only a start in this endeavor, the human engineer and the design engineer work together today to obtain complete quantitative data on the optimal performance of the man-machine combination.



CONVAIR

Traveler

VOL. VIII NO. 9 JANUARY 1957



CONVAIR Traveler

VOL. VIII NO. 9 JANUARY 1957

FOREWORD

Because an aircraft control cable serves a vital function, it is built with an added margin of strength to withstand extreme stresses. This margin of strength is carefully guarded during production and installation of cable assemblies. After installation, however, corrosion and wear can attack any metal, and a control cable is no exception.

If control cables are properly lubricated and inspected at regular intervals, they will give many years of trouble-free service. In this issue of the Traveler, some of Convair's cable lubrication and inspection methods are presented for the information and guidance of operators.

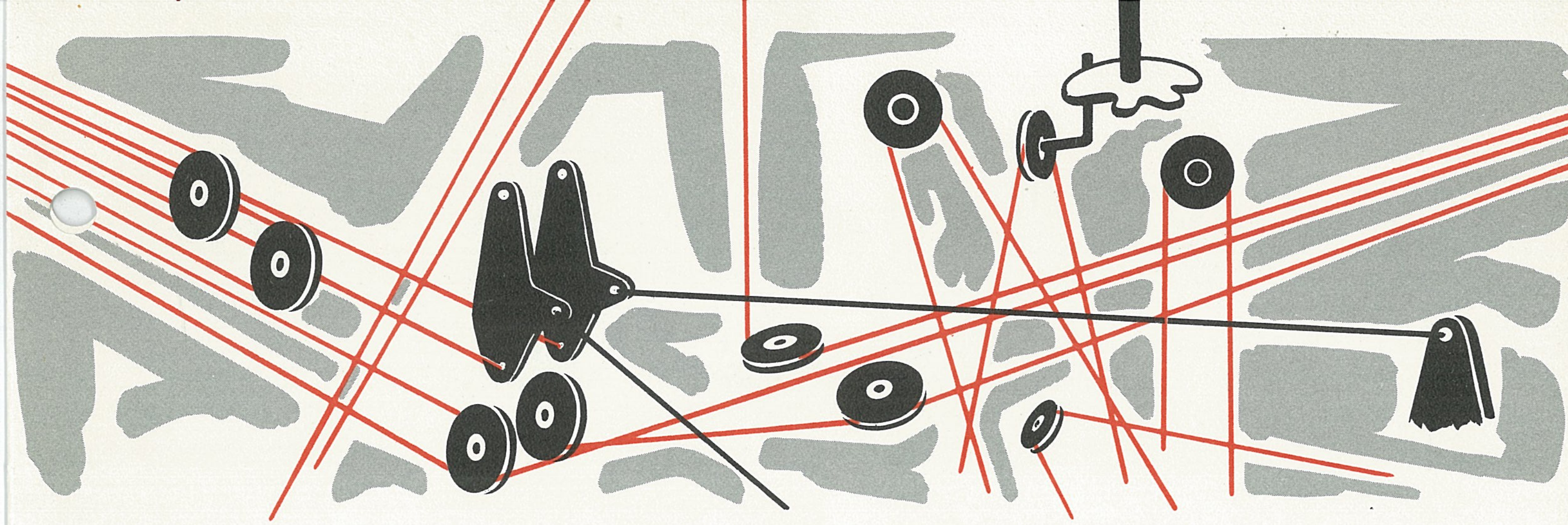
In addition to general information about the care and handling of cables, the Traveler presents some specific information about Convair control cable assemblies. Most control cable assemblies on Convair-Liners are manufactured to standard specifications; however, some special assemblies have been designed to fit particular cases. The dimensions and components of these special assemblies are presented for the convenience of those operators who may need such information.

ON THE COVER

Artist P. Frank Freeman effectively combines control cables and pulleys in an abstract cover design this month.

A digest of Convair-Liner operation and service published monthly by the Service Publications Section of Convair in the interest of Convair-Liner operators. Communications should be addressed to Manager of Service, Convair, San Diego 12, Calif.

The information published in the Convair TRAVELER is to be considered accurate and authoritative as far as Convair approval is concerned. CAA approval, however, is not to be implied unless specifically noted. Recipients of this information are cautioned not to use it for incorporation on aircraft without the specific approval of their cognizant organization.



CONTROL CABLES

Aircraft control cables are constructed of thin wire strands, each strand being an individual unit of hard steel. Thus, if a strand (or strands) is broken, the cable is only gradually weakened.

Every time a cable is stretched around a pulley, or a control column is suddenly moved, an added burden is placed on the cable—a burden which may exceed the normal load by 100 per cent. These stresses are anticipated and so the engineer, after determining all the forces which could be imposed on the cable, adds a safety margin.

Cables before installation are tested, inspected, and lubricated. Then they are installed and retested for tension. After the aircraft is delivered, airline personnel maintain the control system to retain the margin of safety that was built into it.

The type and construction of "wire rope" is indicated by two figures, the first giving the number of strands and the second, the number of individual wires per strand. For example, a 7x7 flexible cable consists of seven strands, each of which is composed of seven individual wires. The more *strands* a cable has, the more flexible it is; therefore, 7x7 and 7x19 cables are used whenever cables pass through pulleys or when bending is necessary. Non-flexible cable consists of 19 wires formed into one strand, such as the 1x19 cable. This strand has little flexibility and thus is used where high strength and minimum deflection are required. It is not intended for operation over pulleys. The use of non-flex cable reduces the number of readjustments necessary during the service life of the cable.

Tests have shown that flexible cables in service may have broken wires without critical loss of strength. A 7x7 cable, for example, may have as many as three broken wires in any one-foot length and still carry its rated load. A 7x19 cable may have as many as six broken wires per foot and still carry its rated load.

Cables can be checked for broken wires by rubbing a cloth over the surface. Broken wires will snag the cloth. Wire breakage occurs most frequently where cables pass through fairleads or around pulleys; therefore, these areas should be checked carefully. Badly corroded or worn cable should be replaced.

Corrosion, if it is unchecked, can destroy cable just as effectively as a hacksaw. To protect cables during manufacture, they are soaked in a hot penetrating lubricant conforming to specification AN-C-124a. Just before they are installed in the aircraft, they are lubricated again according to the following procedure.

First, they are wiped free of accumulated dust and dirt. Then, a solution of four parts of corrosion-preventive compound (Paralketone) conforming to specification MIL-L-7870, is mixed with one part Stoddard Solvent. This solution is then brushed or wiped on the full length of the cables, except in those areas where the cable passes through fairleads or pressure seals. These areas are coated with general purpose lubricating oil or with the lubricant specified on the engineering drawing. Wherever the cable passes over pulleys or drums, it is coated with an all-purpose lubricating oil over the corrosion-preventive compound.

Whenever it has been possible, cable assemblies on Convair-Liners have been manufactured to standard specifications. When it has been impossible to find the exact standard specification to fit a particular requirement, special assemblies, bearing Convair part numbers, have been designed.

Adequate spare cable assemblies should be kept in stock for replacement purposes; however, when supplies are limited, the assemblies may be duplicated in any machine shop equipped with cable testing and swaging machinery.

Temporary fixes should never be attempted on control cables. Spliced cable has only 75 per cent of the strength of the original product. Attachment by means of clips or clamps is equally dangerous because cables held together by this method develop as little as 50 per cent of the strength of a complete cable.

Cable assemblies may be fabricated according to the following procedure:

Compute cable length according to the dimensions given on the engineering drawing. Make allowances for elongation of fittings and proof-testing of cable.

Swaging is the usual method of attaching terminals to cables. Prior to swaging, coat the end of the cable with SAE 10 lubricating oil; then insert the cable end into the terminal. Apply a drop of light oil on the terminal and then, after starting the swaging die at low speed, push the end of the terminal into the hole. Increase the speed of the die and continue to swage the terminal until the dimensions shown in the following tables are reached. If swaged terminals are used on both ends, accurately measure the overall cable length before the second swaging operation. If the terminals have more than the allowable ½-degree bend, straighten them in a vise, using only as much pressure as is necessary.

After swaging, terminals should have a smooth surface which is free of splits, cracks, or other injurious defects. Cable assemblies showing any slippage through the terminal should be rejected.

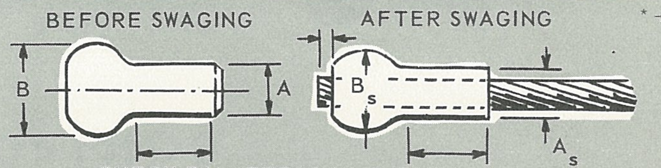
All cable assemblies are proof-tested after swaging. Proof-testing equipment consists of an adjustable frame, which simulates an actual control installation, and a machine which applies a measured load. The entire frame is shielded to protect personnel in the event of cable breakage.

The cable is rigged, then tension is gradually increased until it reaches 60 per cent of breaking strength. This load is held for five seconds, then it is gradually eased. After proof-testing, the assembly is carefully inspected for excessive stretching, broken strands, and terminal slippage; then it is lubricated and installed in the airplane.

TERMINAL AN664 BALL
SINGLE-SHANK DIAMETERS*

NOMINAL CABLE DIAMETER	"A" BEFORE SWAGING	"As" AFTER SWAGING	"B" BEFORE SWAGING	"Bs" AFTER SWAGING	"Cs" DIM.
1/16	.132 –.004	.112 –.003	.212 –.004	.190 –.003	.156
3/32	.168 –.004	.143 –.003	.282 –.004	.253 –.003	.234
1/8	.223 –.004	.190 –.003	.350 –.004	.315 –.003	.313
5/32	.259 –.004	.222 –.004	.424 –.004	.379 –.004	.391
3/16	.298 –.005	.255 –.005	.492 –.005	.442 –.005	.469
7/32	.352 –.005	.302 –.005	.560 –.005	.505 –.005	.547
1/4	.406 –.005	.348 –.005	.629 –.005	.567 –.005	.625
9/32	.444 –.005	.382 –.005	.699 –.005	.632 –.007	.750
5/16	.480 –.005	.413 –.005	.768 –.005	.694 –.007	.813

* +.000

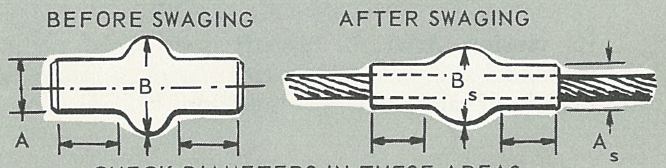


CHECK DIAMETERS IN THESE AREAS

TERMINAL AN663 BALL
DOUBLE-SHANK DIAMETERS*

NOMINAL CABLE DIAMETER	"A" BEFORE SWAGING	"As" AFTER SWAGING	"B" BEFORE SWAGING	"Bs" AFTER SWAGING
1/16	.127 –.004	.112 –.003	.207 –.004	.190 –.003
3/32	.163 –.004	.143 –.003	.277 –.004	.253 –.003
1/8	.218 –.004	.190 –.003	.345 –.004	.315 –.003
5/32	.254 –.004	.222 –.004	.419 –.004	.379 –.004
3/16	.293 –.005	.255 –.005	.487 –.005	.442 –.005
7/32	.347 –.005	.302 –.005	.555 –.005	.505 –.005
1/4	.401 –.005	.348 –.005	.624 –.005	.567 –.005
9/32	.439 –.004	.382 –.007	.694 –.005	.632 –.007
5/16	.475 –.005	.413 –.007	.763 –.005	.694 –.007

* +.000



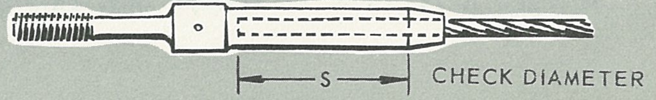
CHECK DIAMETERS IN THESE AREAS

AN658, AN666, AN667, AN668, AND AN669 TERMINALS

NOMINAL CABLE DIA	TERMINAL DIAMETER BEFORE SWAGING*	TERMINAL DIAMETER AFTER SWAGING**	"S" DIM.†
1/16	.160	.138 –.005	.70
3/32	.218	.190 –.005	.80
1/8	.250	.219 –.005	1.05
5/32	.297	.250 –.005	1.29
3/16	.359	.313 –.005	1.31
7/32	.427	.375 –.007	1.55
1/4	.494	.438 –.007	1.70
9/32	.563	.500 –.008	1.89
5/16	.635	.563 –.008	2.06
3/8	.703	.625 –.008	3.15

† These dimensions are not applicable to AN658.

* +.000 –.005
** +.000



If the cable is not to be installed immediately, certain precautions should be taken in care and handling. A cable which is coiled too tightly, or handled too roughly, may become distorted. Cable should be coiled to a diameter which is no smaller than that given in the following table; if it is to be suspended from a hook or rod, it should be placed on a support with a radius of four or more inches.

MINIMUM COIL DIAMETERS
(PROOF-TESTED CABLE ASSYS)

	MINIMUM COIL DIAMETER	
CABLE DIA	INCHES	FEET
1/16	9	–
3/32	14	(–)
1/8 to 5/32	24	2
3/16 to 1/4	36	3
9/32 to 5/16	48	4
11/32 to 3/8	60	5

When control cable loads and stresses are computed, they are based on a specific tension and temperature. The recommended tensions and temperature variation allowances noted on the engineering drawing are designed to give maximum service and safety. These allowances should be strictly adhered to. Incorrect tension is not only damaging to the cable and related installation, but it may affect the handling or even the safety of the aircraft.

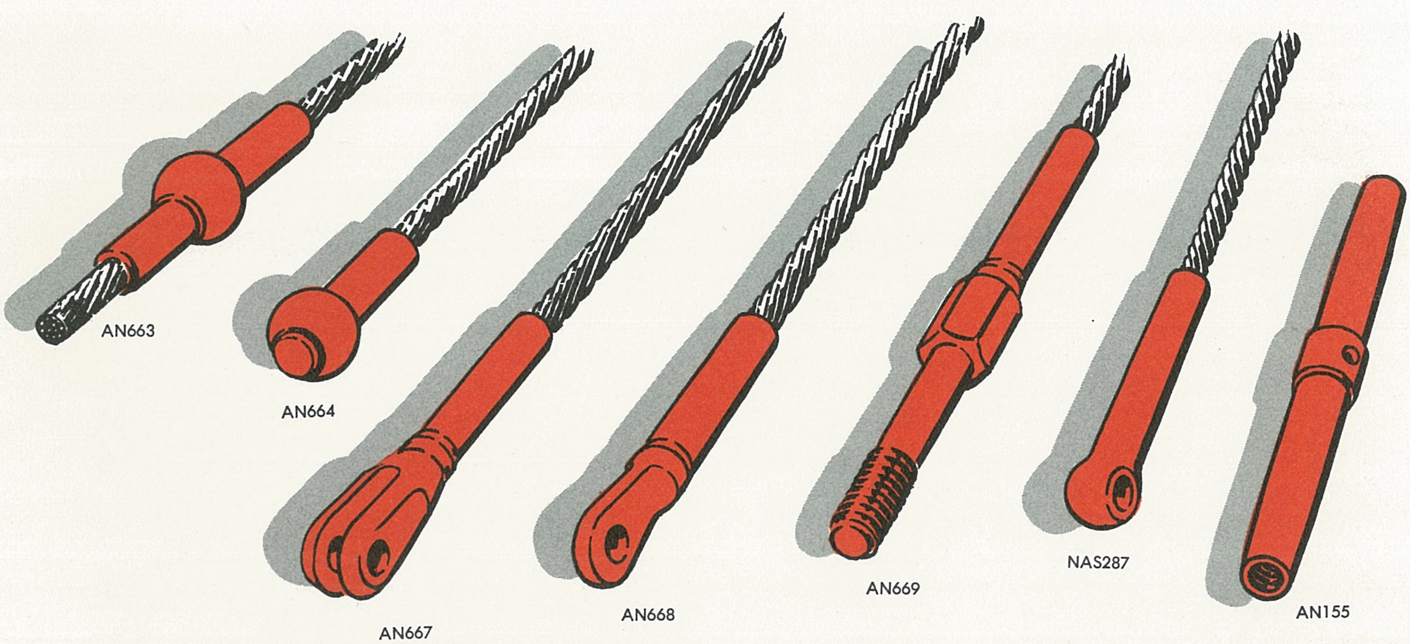
Maintenance personnel can measure control cable tension scientifically and accurately by means of a tensiometer. This compact precision instrument is slipped over the cable, the trigger is pulled, and tension is registered on a dial. The numbers on the dial are then converted to pounds of pressure by reference to a table attached to the inside of the lid of the tensiometer storage box.

Each instrument is individually calibrated with a particular table; therefore, when the tensiometer is used, the number on the instrument should be checked against the number on the box.

Tensiometers are equipped with a locking device for use in locations where it is difficult or impossible to read the dial. After the instrument is secured to the cable, the lock is engaged, fixing the pointer. The tensiometer may then be released and removed for easy reading. The pointer will remain at the reading until the lock is released. The lock should not be closed unless the trigger is closed, because closing of the trigger, while the lock is engaged, will damage the mechanism.

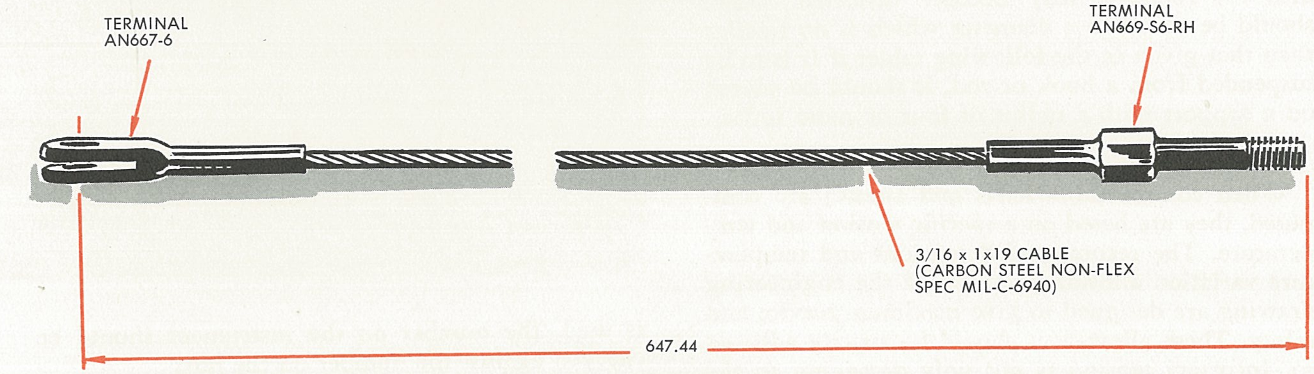
Tensiometers should be calibrated at least once a month; however, if the instrument has been dropped or subjected to a shock, or if it fails to give a logical reading, it should be recalibrated immediately.

TYPICAL SWAGED CABLE TERMINALS

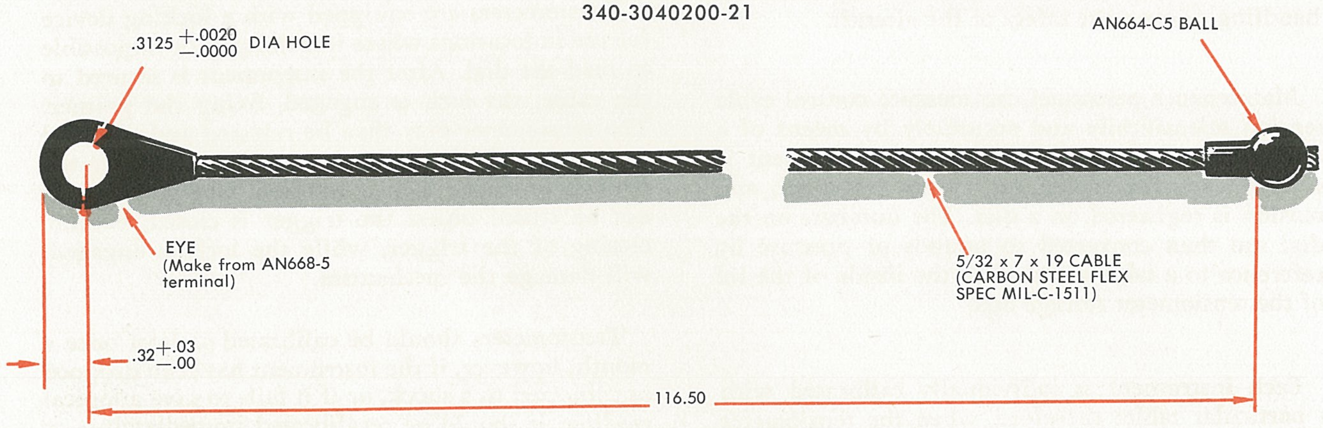


RUDDER CONTROL

340-3040200-11



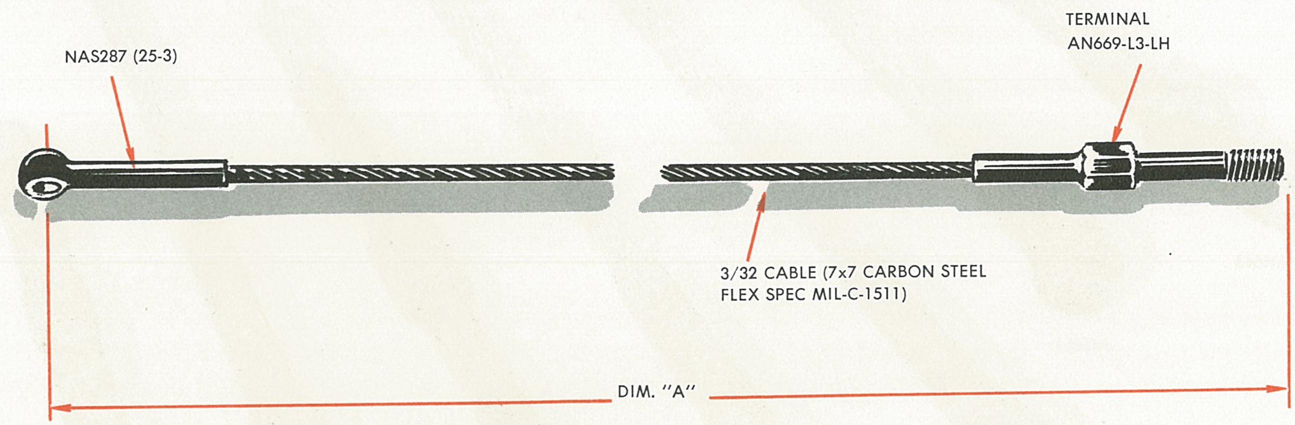
340-3040200-21



NOSE WHEEL STEERING

340-3150621 (basic)

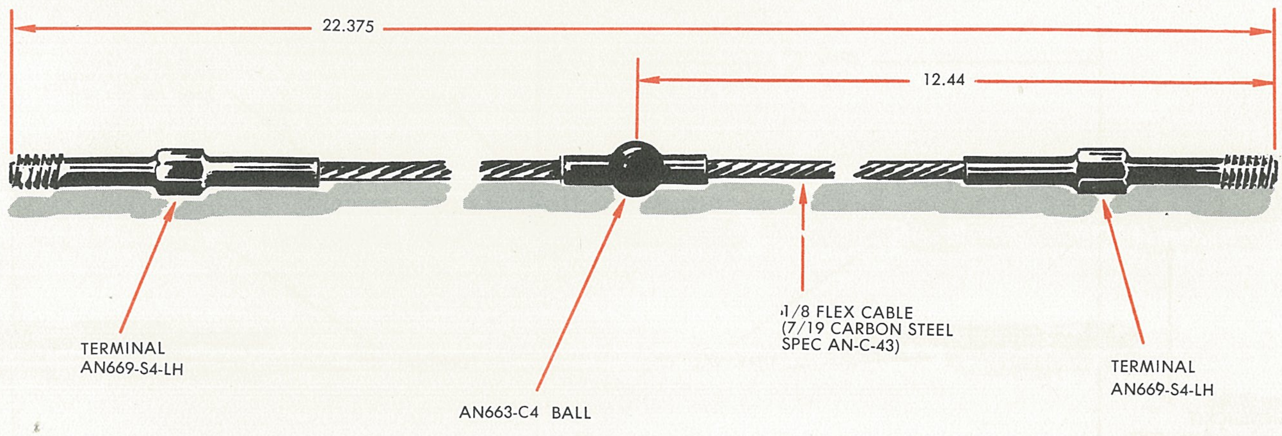
340-3150621-1



CABLE ASSY	DIM. "A"	CABLE LENGTH
340-3150621	61.25	59.3
340-3150621-1	53.50	51.5

ELEVATOR CONTROL SYSTEM

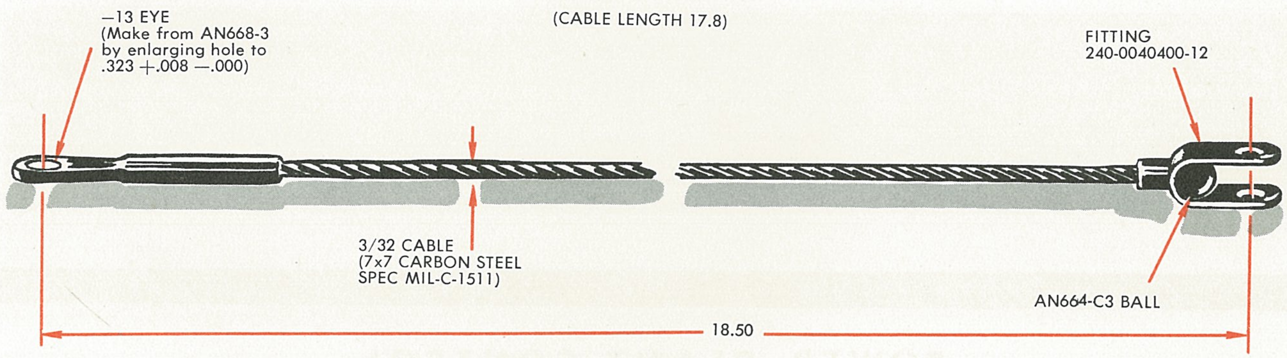
340-3040300-9



INTERCONNECT CABLE ASSEMBLY

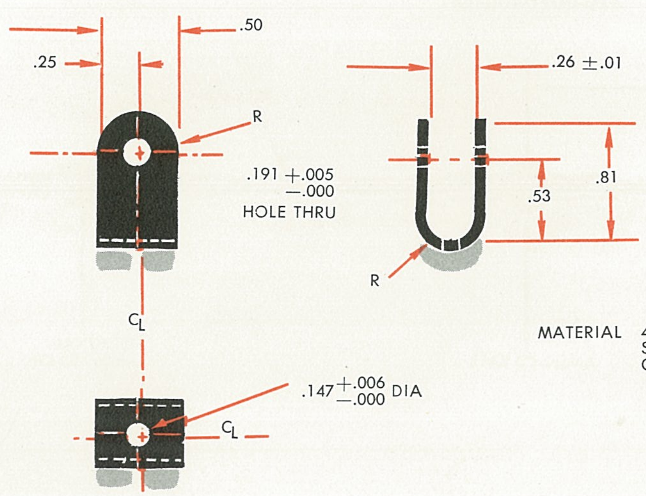
340-3347113-11

(CABLE LENGTH 17.8)



FITTING

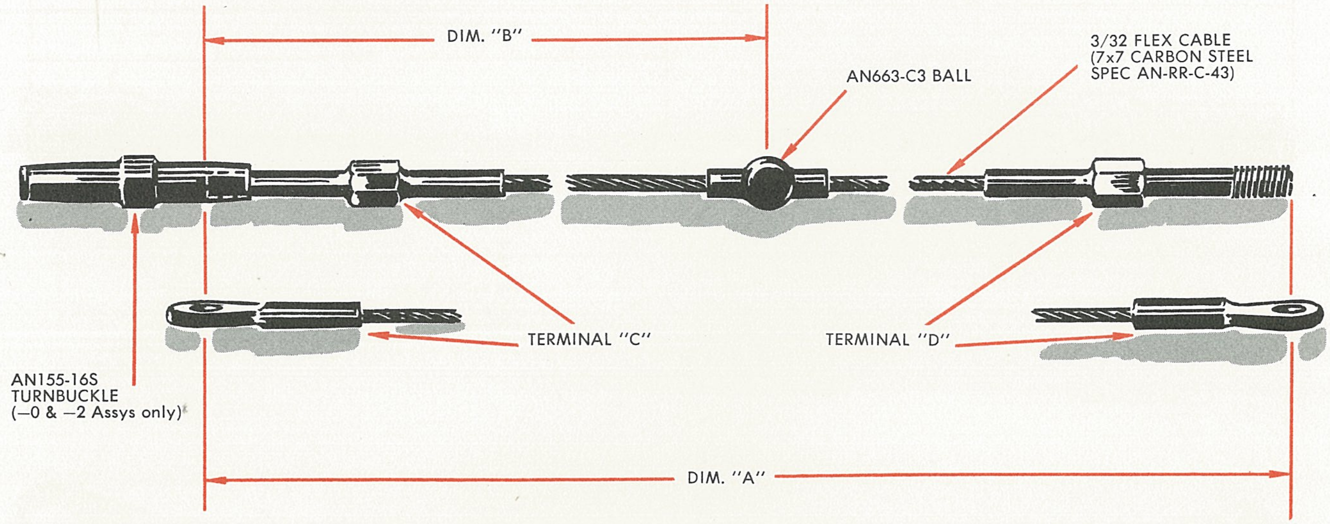
240-0040400-12



MATERIAL 4130 STEEL .062 THICK
SPEC AN-QQ-S-685
COND "N"

PEDESTAL CABLE ASSEMBLIES

240-3127404

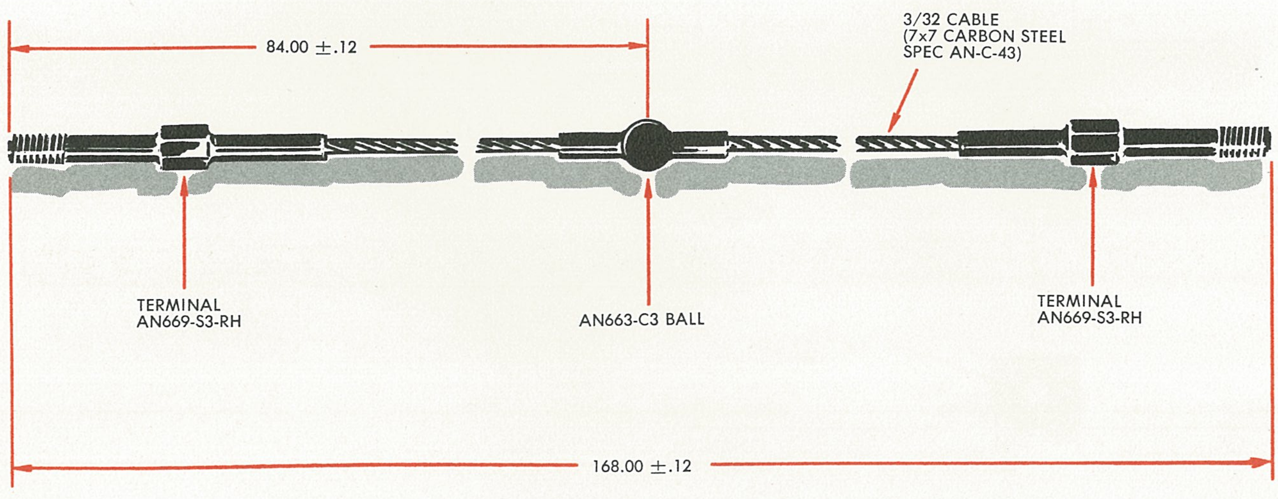


CONTROL SYSTEM	ASSEMBLY NO.	DIM. A	DIM. B	TERMINAL C	TERMINAL D	CABLE LENGTH
THROTTLE REVERSE MECHANISM	240-3127404-0	26.48	13.24	AN669-S3-LH	AN669-S3-RH	23.18
	240-3127404-2	22.26	11.13	AN669-S3-LH	AN669-S3-RH	18.96
CARBURETOR AIR MIXTURE	240-3127404-12	24.84	12.42	AN669-S3-RH	AN669-S3-RH	21.55
	240-3127404-16	20.00	10.00	AN668-3	AN668-3	17.75

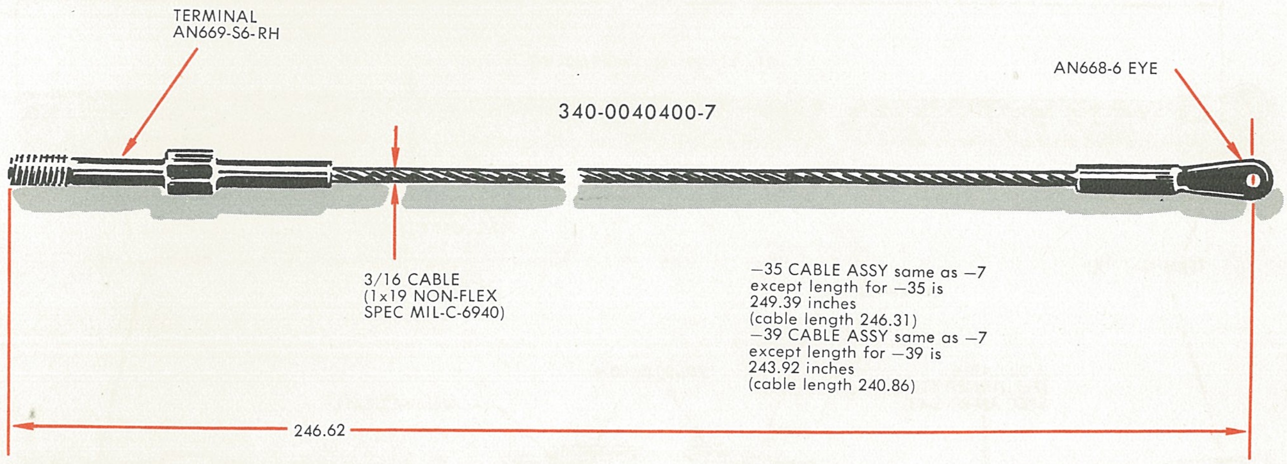
POWER PLANT CONTROL

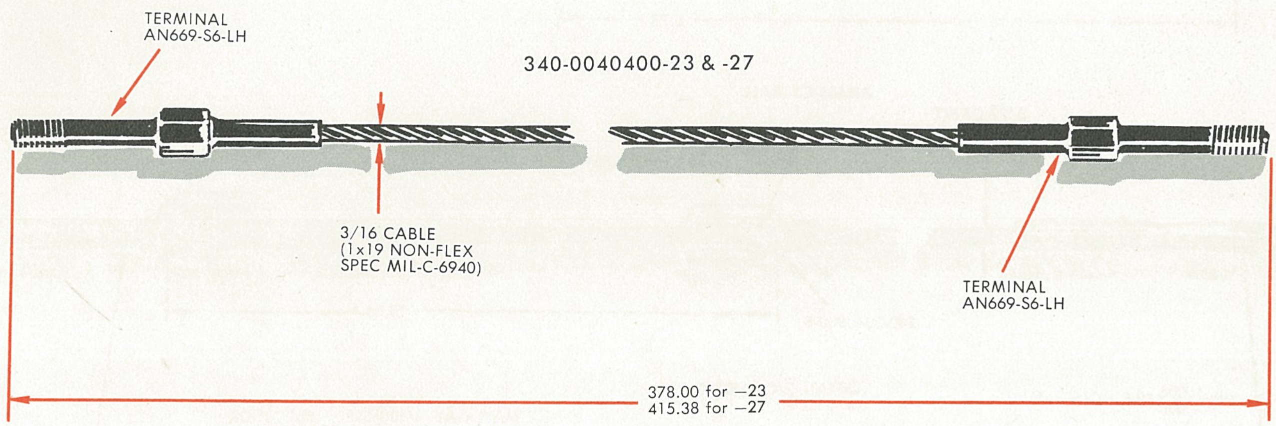
(CARBURETOR ALTERNATE AIR)

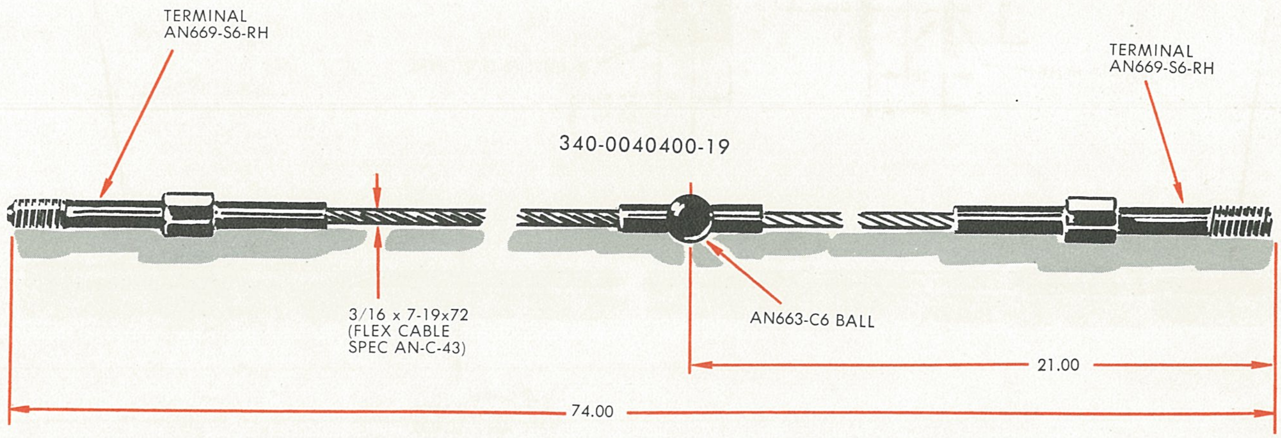
340-0020400-13



AILERON CONTROL CABLES

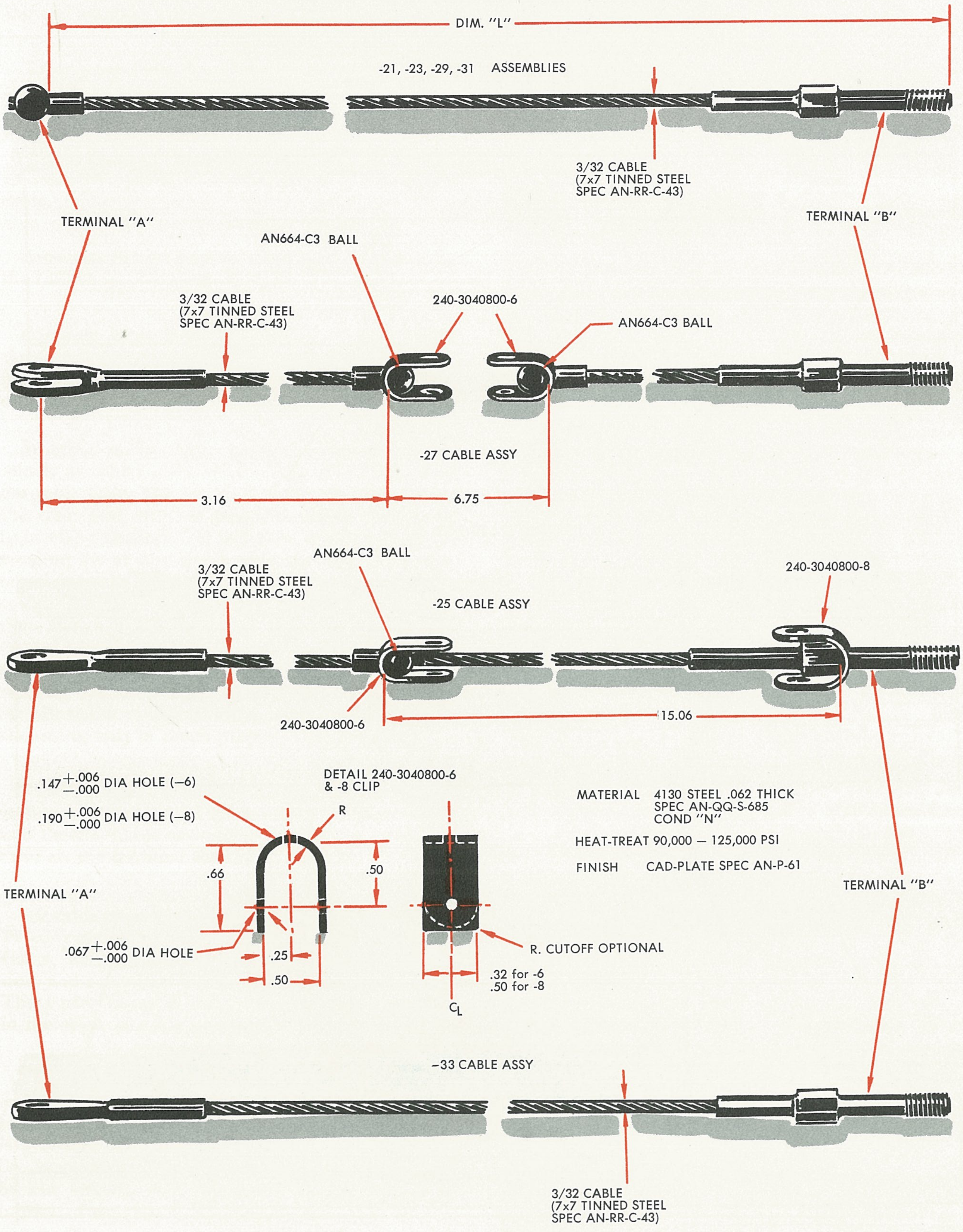






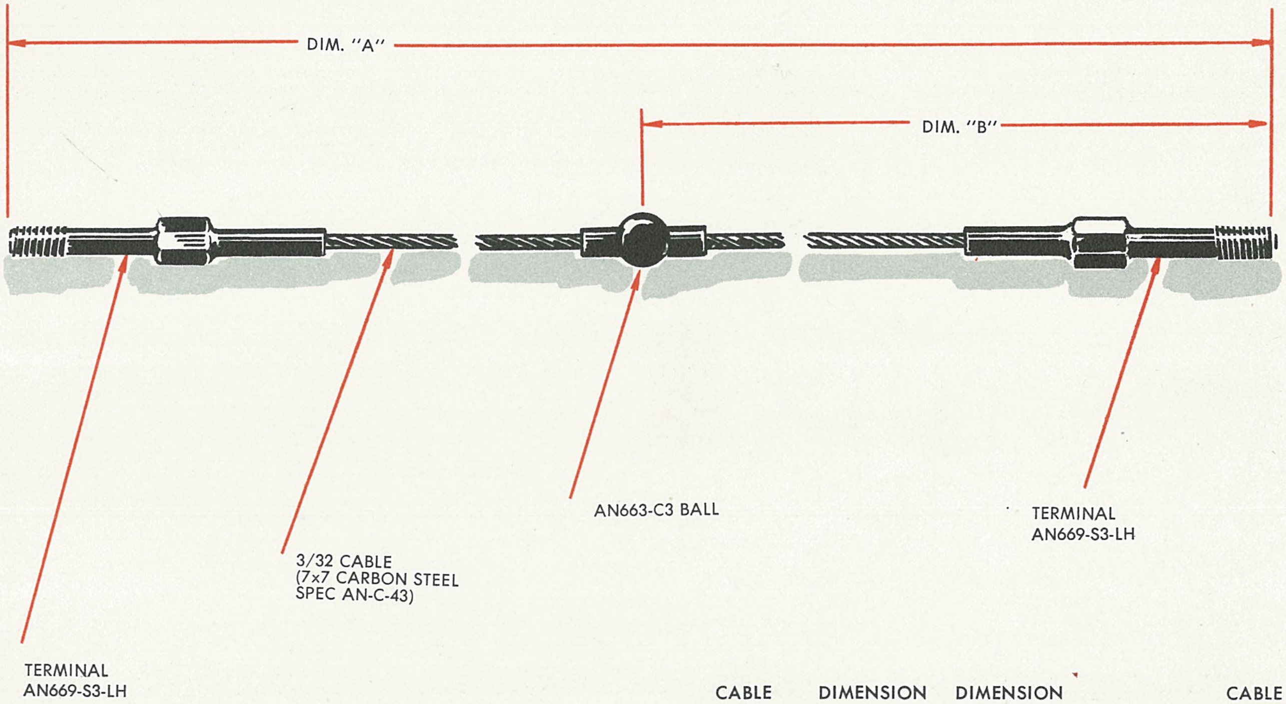
LANDING GEAR CONTROLS

340-0050600



ASSEMBLY NUMBER	TERMINAL "A"	TERMINAL "B"	DIM. "L"	CABLE LENGTH
340-0050600-21	AN664-C3	AN669-S3-LH	8.50	7.00
340-0050600-23	AN664-C3	AN669-S3-RH	50.25	50.00
340-0050600-25	AN668-3	AN669-S3-LH	31.37	29.75
340-0050600-27	AN667-3	AN669-S3-LH	44.00	46.00
340-0050600-29	AN668-3	AN669-S3-RH	140.37	138.75
340-0050600-31	AN668-3	AN669-S3-RH	135.75	134.12
340-0050600-33	AN668-3	AN669-S3-LH	267.00	286.00

NACELLE FLUID VALVE CABLE ASSEMBLIES



CABLE ASSEMBLY	DIMENSION "A"	DIMENSION "B"	CABLE LENGTH
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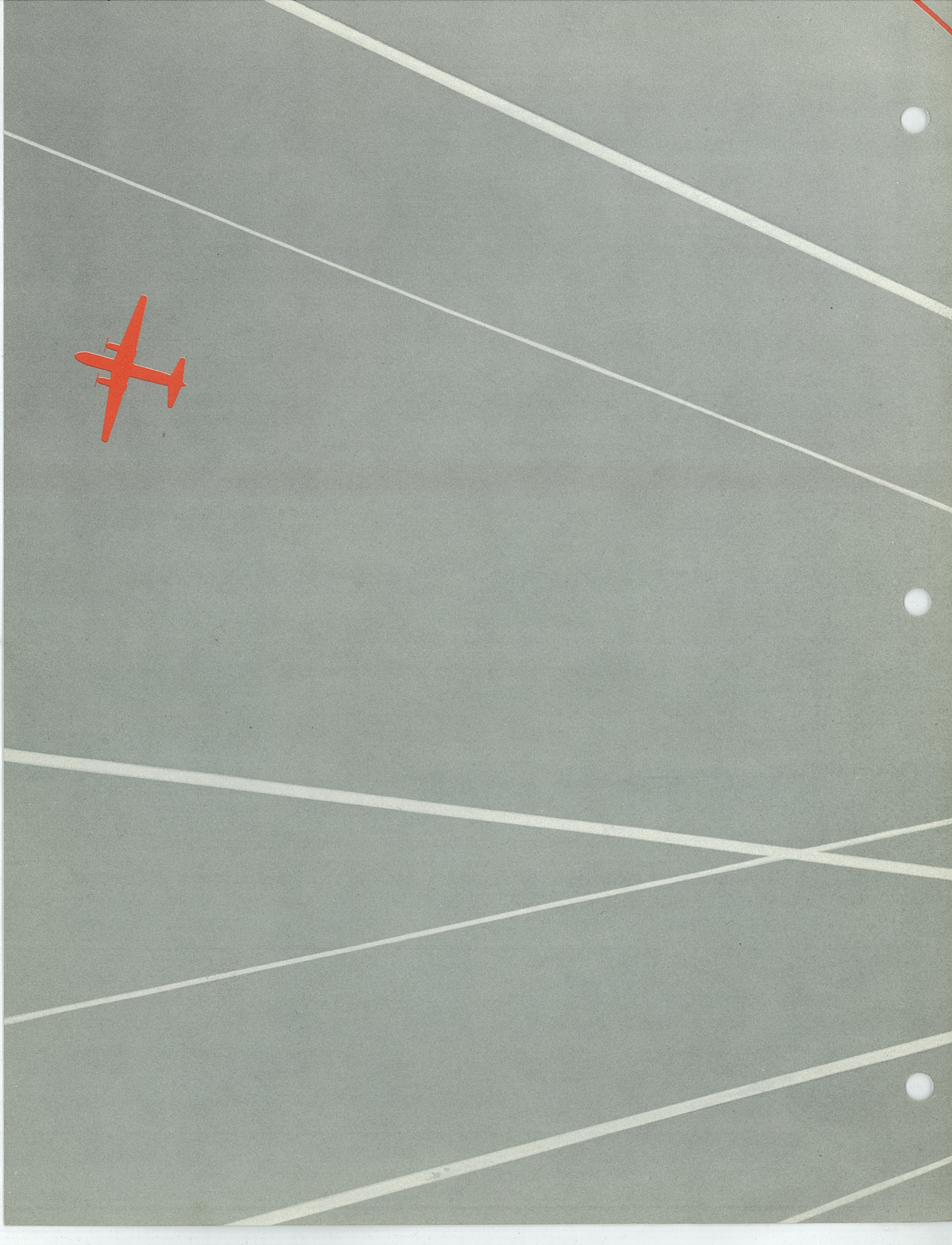
340-0090301-11	59.0	28.9	57.0
340-0090301-25	31.3	15.6	29.5



CONVAIR

Traveler

VOL. VIII NO. 10 FEBRUARY 1957

CONVAIR *Traveler*

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FOREWORD

While a new model is still in the blueprint stage, manufacturing research technicians are solving problems which will arise during production.

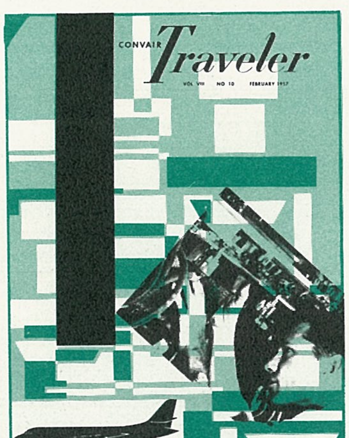
In today's complex, highly-organized aircraft industry, the solution to production problems cannot be postponed until an aircraft is actually in production, because unsolved problems cause expensive delays which disrupt manufacturing schedules.

The anticipation and solution of production problems at Convair are functions of the Manufacturing Research and Development Group, a highly-skilled team of technicians from every field of engineering and many fields of science. This month, the Traveler describes some of the recent accomplishments of this important group.

ON THE COVER

Our cover design this month portrays two of the major projects of Convair's Manufacturing Research and Development Group. In the foreground, an engineer inspects a sheet of steel honeycomb. In the background is an artist's conception of the explosive forming press. Both of these projects are being developed for use in the production of future Convair models, such as the 880.

The Artist . . . Richard Denison



A digest of Convair-Liner operation and service published monthly by the Service Publications Section of Convair in the interest of Convair-Liner operators. Communications should be addressed to Manager of Service, Convair, San Diego 12, Calif.

PRODUCIBILITY BARRIER

MRD manufacturing research and development

The term "barrier," as it is used in the aircraft industry, usually refers to an obstacle that impedes scientific development. During the past decade, aircraft designers have reached such impediments as the sonic and thermal barriers.

The advent of numerous barriers is primarily due to the fact that airspeed, in relation to calendar years, has increased more in the years following World War II than in all the previous history of man. This sudden advancement in aircraft design has created many manufacturing problems . . . problems that may be solved only by intensive research and experimentation. Increased demands on production skills and equipment have created a new obstacle to progress—the producibility barrier.

Although this new barrier will probably never be completely overcome, it must be constantly attacked, contained, and pushed ahead as scientific development advances. It is imperative that producibility — that is, the ability to produce — will not be restricted by lack of manufacturing know-how.

Keeping the producibility barrier parallel with scientific development is the function of Convair's Manufacturing Research and Development group. This function requires varied skills, because problems arise during every phase of the production process. Convair's research team comprises tooling specialists, mechanical, electrical, and electronics engineers, metallurgists, chemists, and technicians from every field.

Most manufacturing research starts with a challenge. Production speed, weight saving, product improvement and application of new materials are everyday problems. Some require an improvement of existing processes . . . others the entire cycle from engineering theory to shop practice.

Solving problems is only part of the function of Convair's research team. Many production problems must be anticipated before a new model reaches the production stage. At the present time, for example, researchers are studying materials and processes which will be used in the production of Convair's new jet-liner, the 880.

titanium study

One of the most troublesome characteristics of titanium is that the amount of pressure required to bend the metal is uncomfortably close to the amount of pressure required to break it.

Convair's Manufacturing Research and Development group knew about titanium before it was ever used on Convair aircraft; they knew that it was a sensitive metal, but that it had characteristics which made it essential in the production of low-weight, high-performance airplanes. They knew that it would have to be worked within strict limits, so they started research to establish an acceptable manufacturing process.

The researcher secured samples of every gage and grade of titanium; then they started to work. When they cut it, they varied rates of feed and speed, and tried every possible combination of saw blade size and tooth spacing. Then they tested all of these variables on various titanium alloys.

They used the same scientific method to find the best way to form titanium. It was a slow, tedious

process, with all of the difficulties and blind alleys which are found in every field of research, but when their experiments were completed, they were able to fabricate titanium parts which would have been considered impossible to produce a few years ago.

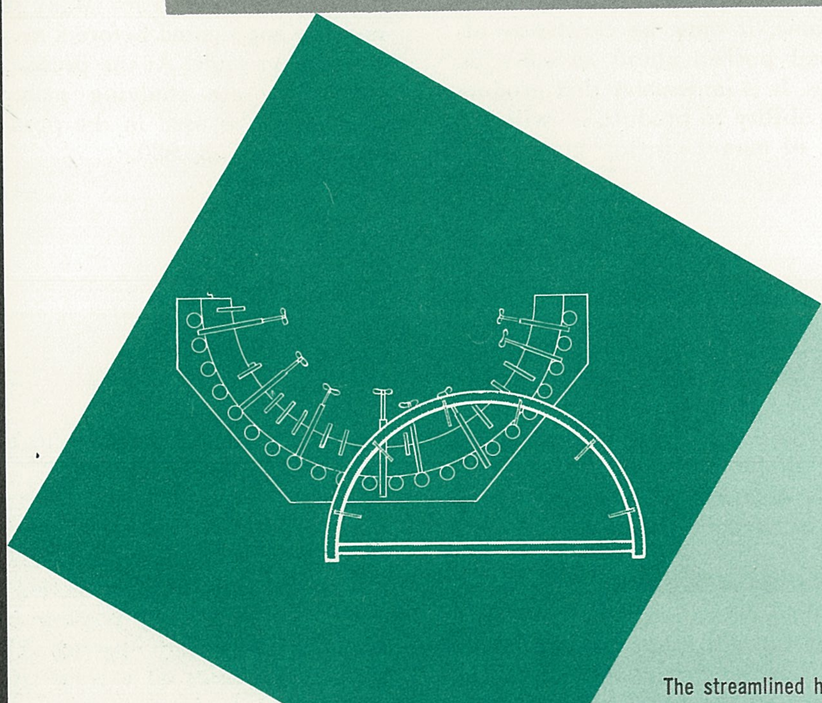
The findings of the Manufacturing Research and Development group were incorporated into manufacturing process specifications which are now standard procedures at Convair; but research is continuing. A complete series of tests must be run on each new titanium alloy that is developed, and new cutting and forming methods are constantly being tested on titanium.

One recent project involved a search for a stretch-forming machine designed to operate within titanium's narrow range between yield and ultimate strength. The Manufacturing Research Department felt that a machine which could automatically "sense" the breaking point of the metal would eliminate a lot of human errors, and improve the quality and uniformity of titanium parts.

At the time the researchers started their investigation, the only available equipment of this nature consisted of an electronic control which was attached to a stretch-form machine. The attachment could be preset to cut off pressure before the breaking point was reached. Although the electronic control was adequate for some operations, the researchers continued to investigate new equipment as it was developed, until they discovered a machine which met with Convair's requirements.

Another recent problem which was solved by Convair research concerned the manufacture of titanium rivets. When titanium alloy wire was manufactured into rivets by conventional methods, cracking and bursting of the wire caused excessive rejections. This problem was solved by the simple expedient of forming the rivets with two "hits" instead of one.

Due to the large number of rejections, titanium rivets formerly cost over a dollar apiece. Now, double-impact rivets can be manufactured for a fraction of the former cost.



The streamlined heat-treat fixture in foreground was developed by MRD group to replace bulky tool in background. The new fixture is used to maintain contour of titanium beltframes during heat-treat operations.

honeycomb sandwich panels

The need for new light-weight, high-strength materials, which accelerated the development of titanium during the past decade, has given rise to a new type of aircraft construction . . . the honeycomb sandwich panel.

Aircraft designers have long known that honeycomb, because of its columnar structure, has a high strength-to-weight ratio. Until recently, however, they were unable to use honeycomb panels in aircraft basic structure, because no known adhesive was strong enough to maintain a bond between metal and non-metal under the stresses of high-speed flight.

The Manufacturing Research and Development group evaluated a number of metal-to-metal adhesives, and they discovered that one of these, an epoxy-phenolic base substance created by the Shell Development Company, maintained a strong bond between metal skin and fiberglas despite heat and friction generated during laboratory tests. Discovery of the new adhesive made it possible for designers to bring honeycomb sandwich panels into maximum use on Convair's supersonic bomber, the B-58. Honeycomb will also be widely used on Convair's new jet-liner, the 880.

In addition to increasing strength while saving weight, honeycomb sandwich panels increase aerodynamic smoothness, and they serve as insulators against outside heat or cold because of the air spaces between the panels.

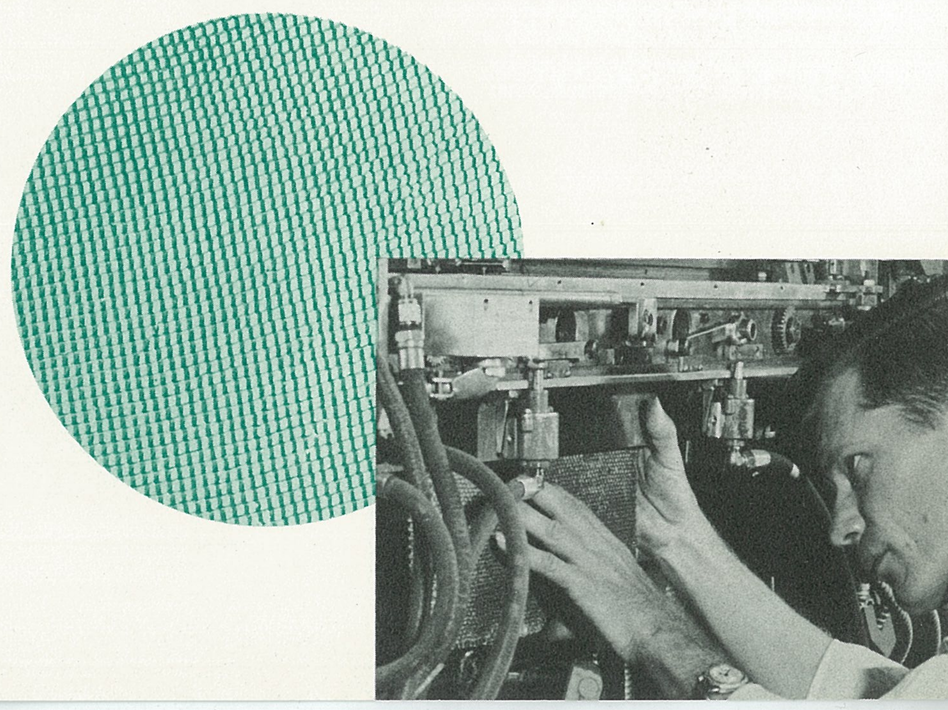
Part of the strength of sandwich panels comes from the even distribution of stress over the entire skin surface, eliminating stress concentration points created by the use of conventional fasteners.

Convair's Manufacturing Research and Development group recently designed a machine to manufacture corrosion-resistant steel honeycomb, automatically. A ribbon of .0015 steel is fed into the machine from a spool. The machine bends the metal strip into a row of small ridges and valleys. This is one-half of one row of cells in a finished honeycomb.

The machine then forms a second row with identical ridges. The two rows are joined and welded at each spot where the ridges touch. This process continues automatically until a full sheet of honeycomb core is complete.

The machine, which is constructed to fabricate one-inch core, is still in the development stage. The basic problem at the present time is developing the exact pressure, time, and current required to weld the ribbon.

Finished corrosion-resistant steel honeycomb core must be brazed, rather than bonded with an adhesive, to skin of the same material. Convair's Manufacturing Research and Development group have developed a process in which steel honeycomb can be brazed automatically.



A thin steel ribbon is inserted into one end of this machine and a sheet of high-strength, low-weight honeycomb comes out the other end. Honeycomb was formerly manufactured in a series of semi-automatic operations.

dynamic etching

A considerable saving in weight is effected by the extensive use of honeycomb sandwich panels and titanium in jet aircraft; however, aircraft designers are constantly looking for new methods to reduce weight in order to increase efficiency and economy.

One such method is machine milling of structural members, whereby all excess metal is removed from heavy aluminum forgings, extrusions, or plate by a slow, costly machining process. Many other components on an aircraft could be milled in this manner, but the cost of machining thousands of small areas would far exceed the amount that could be saved in weight.

Recently, a new process was developed in which excess metal was removed by dynamic etching rather than by machine milling. In this process, the material is covered entirely with a resilient masking substance; then areas to be chemically removed or partially removed, are outlined with a sharp knife. A thin-gage steel template is used as a guide. The mask is then peeled away from these areas to expose the metal which is to be removed.

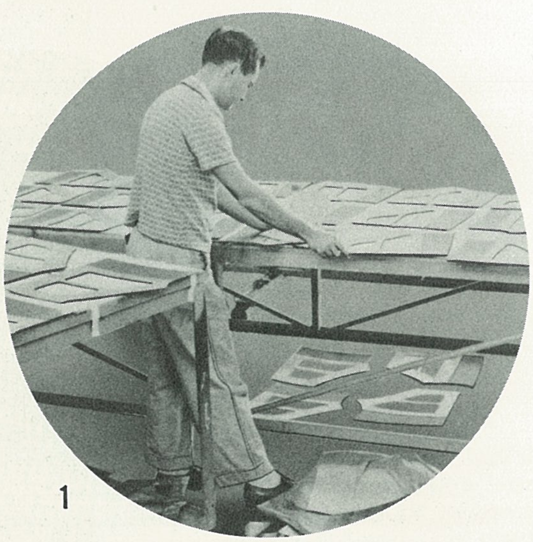
From the masking room, the production part goes to a heat oven where it is baked at a high temperature to toughen the covering.

The part then goes directly to a tank of hot etching fluid. It is left in the etching tank long enough to remove a predetermined amount of metal which is not protected by the mask. The rate of removal for aluminum is approximately .001 inch per minute.

Convair's research team, working in conjunction with Oakite Corporation, manufacturers of chemicals, tested various masking materials, etchants, and scribing tools to determine the most efficient method of dynamic etching for Convair applications. The research group set up a manufacturing specification for the process which included materials, techniques, and procedures, and they recommended that the Company establish a Dynamic Etching department equipped to handle a heavy workload.

The experiments and research of the group have resulted in a tremendous increase in the number of parts processed, and have also resulted in a considerable weight saving. Only eight parts on the F-102A, Convair's all-weather interceptor, were formed by Dynamic Etching; on later models of this aircraft, 200 parts, having an area of more than 700 square feet, will have excess material removed by etching.

At the present time, only aluminum parts on military interceptors are being dynamic etched; however, Convair researchers are currently testing various etchants and masking materials on magnesium, steel, and titanium. As increasing speed requirements accentuate the weight problem on commercial jet-liners, etching will be extended to nonmilitary models.



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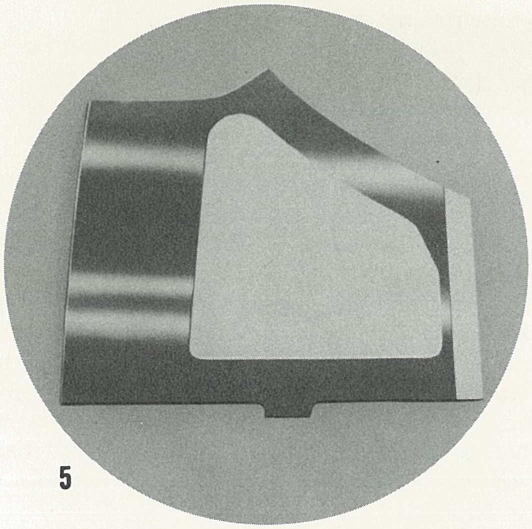
2



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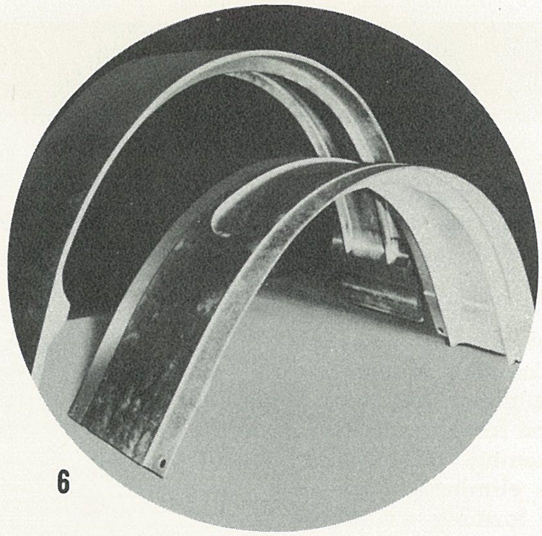

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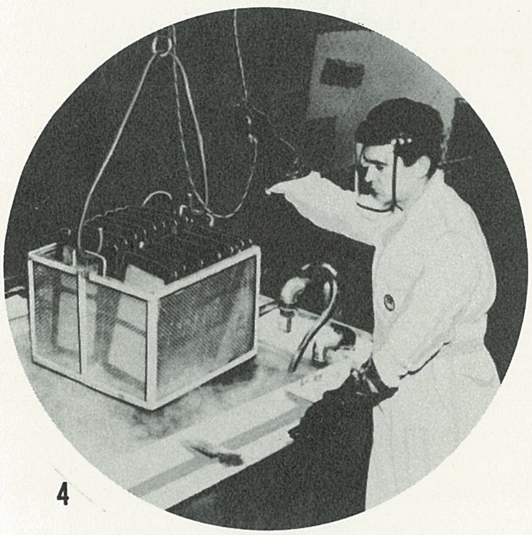


4

3

1. Parts are masked with an acid-resistant material.
2. Mask is scribed around template.
3. Protective masking is removed from the portions of part which are to be etched.
4. Parts are placed in etchant solution.
5. After predetermined amount of material is removed, part is taken from etchant and rinsed. Finished parts have smooth unblemished surface.
6. Dynamic etching makes it possible to mill such complex contoured parts as this skin section.

explosive forming

When parts are returned from hydropress or drop-hammer forming operations, they must be finish-formed by hand to remove small surface dents and unevenness.

Hand-forming is slow and expensive and, for several years, Convair's Manufacturing Research and Development group has been attempting to improve machine forming methods to minimize costly hand-straightening. Hand finish-forming has not, as yet, been eliminated, but new "trapped rubber" impact forming techniques have reduced it considerably. The new process raises peak pressures from the 3000 psi slow squeeze of the hydropress to a fast drop-hammer impact of 10,000 psi. The part is pushed into a bed of trapped rubber by the drop-hammer.

The success of high-pressure forming on aluminum parts led Convair researchers to reason that even higher pressures might be used to solve forming problems on the increasing number of high-strength steel and titanium parts, which are required on high-performance aircraft.

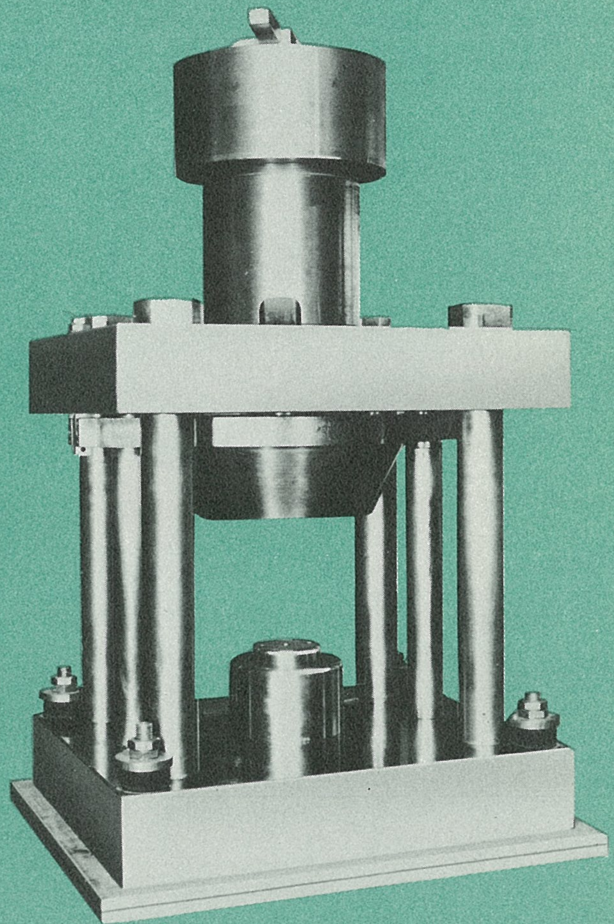
Because explosives can produce greater impact pressures than can any contemporary mechanical forming equipment, the Convair research team began a series of experiments in which they used gunpowder to increase the impact velocity of a forming press. Early experiments were promising; however, the press was unable to withstand the sudden stress of the exploding charge.

The researchers solved this problem by redesigning the press so that it could withstand the explosive charge. The redesigned forming press is a relatively simple piece of equipment which combines the principles of a shotgun and a drop-hammer. It consists of a breech assembly, shell housing, and a movable ram or piston, which is held against the housing by shear pins.

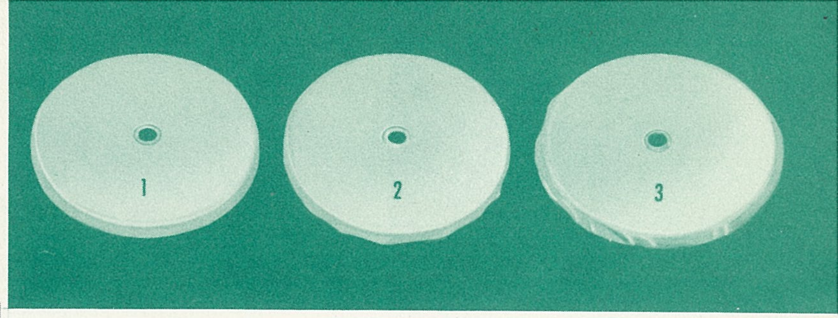
After a blank is placed on the die at the base of the press, a powder charge is placed in the housing, and the breech assembly is secured. When the charge is fired, a piston is propelled with bullet-like velocity against the blank part. As it strikes the part, with an impact pressure of 30,000 to 50,000 psi, trapped rubber in the piston head forces the part downward over the die.

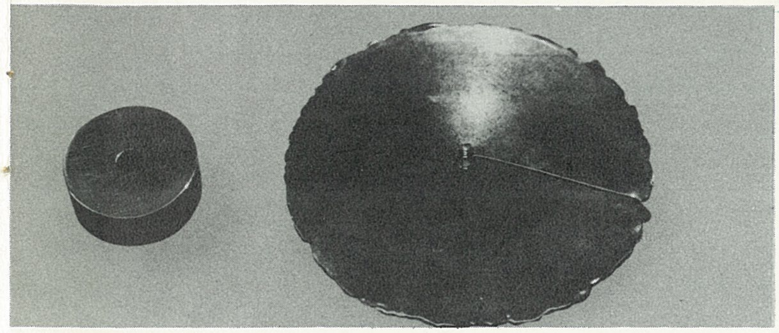
Experimental parts produced on this small test press have been more perfectly formed than have identical parts formed on a 4500-ton hydropress.

The success of high-pressure forming has generated a considerable amount of enthusiasm at Convair and elsewhere in the industry; however, the process is not yet ready for production use. At the present time, Company researchers are investigating the use of higher impact pressures and their effect on the structure of various aircraft metals.



A full-size explosive forming press, similar to this experimental model, may soon be used to form aircraft parts at Convair.





Part No. 1, which was formed on the explosive press, requires less hand finish-forming than parts 2 and 3, which were formed on a drop hammer and hydropress.

A heavy lead slug, similar to the one on left, was smashed flat by force of gunpowder-actuated piston in explosive forming press.

automation

In their efforts to reduce production time, Convair researchers are investigating many applications of automation in the aircraft industry.

Convair is now using a machine which drills and rivets an entire wing skin and stringer assembly automatically. Specifications for the assembly are translated onto a film tape, then to an electronic brain. Without further human intervention, the machine is guided over its multiple operation in response to the punched indications on the moving tape.

Another recent development in the field of automation is the Opticopy, a machine that accurately reproduces complex metal parts by merely "looking" at a template.

To place the machine in operation, the operator guides a light beam to the start of the line to be followed; then the electronic "eye" takes over, guiding the cutting tool through the metal part to be formed.

Computers save many manhours in the field of design engineering by solving complex problems rapidly and efficiently. Convair's Research and Development group is accomplishing a similar saving in the field of manufacturing with a "machinability computer."

Known information, such as type and condition of material and configuration of the tools to be used, is fed into the machine. Finding the correct machining speed for a desired tool life formerly required hours of mathematical computation; now, the machinability computer can produce the correct answer in seconds.

When the machinability computer is used in conjunction with another Convair development—throw-away carbide inserts—machine down-time due to tool change or sharpening is reduced to a minimum.

Each carbide insert costs less than a dollar, yet each has eight cutting edges. When an edge becomes worn, it can be changed quickly, and work can continue without delay.

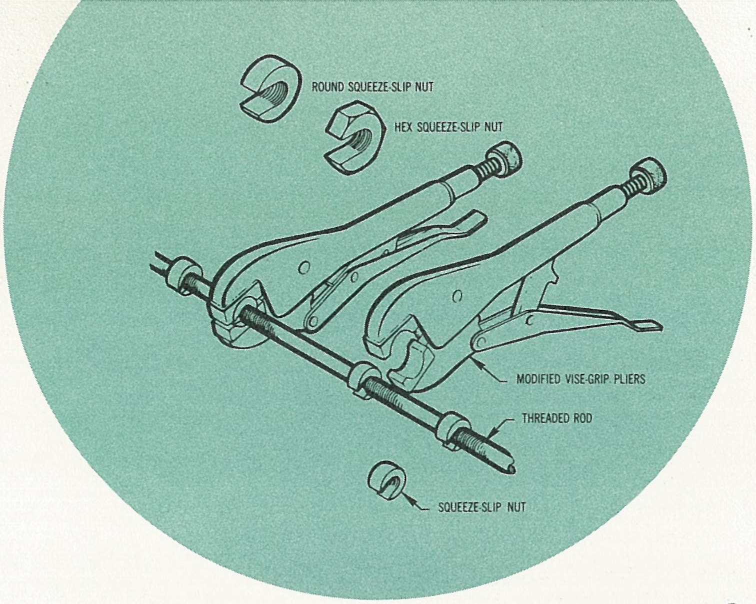
Most of the activities of the Manufacturing Research and Development group are concerned with improvements in manufacturing processes; however, while researchers are finding better ways to build airplanes, they are also finding better ways to repair and maintain them.

One such improvement, which can be used in any machine shop, is the spacematic drill, a device which fixes the spacing of a series of holes to be drilled; another tool has been developed which automatically regulates the rate of feed.

In model and mockup work, thousands of manhours have been expended threading nuts onto long rods. Following an employee suggestion, Convair researchers developed a slip-squeeze split nut which saves $76,000 per year on this single operation.

automation

A



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B

A Slip-squeeze nuts and special washers were designed to eliminate tedious and costly hand-threading operation in mock-up applications.

B This special drill, which automatically spaces two holes for installation of nutplates, has saved many production hours.

VAPOR BLASTING

Vapor blasting is a process in which a jet mixture of vapor and abrasive is directed against a metal part. The process has been used at Convair for many years as a method of imparting a high polish to some aircraft parts.

Recently, a study of the effect of vapor blasting on the fatigue life of metals was conducted by the Manufacturing Research and Development group. Test results revealed that vapor blasting greatly increased the fatigue life of all metals tested. Titanium fatigue life was nearly doubled by the operation, and the fatigue life of 7075-T6 aluminum alloy was increased by 3820 per cent.

corrosion resistance

Corrosion resistance is an acute problem which is shared by airline operators and aircraft manufacturers. Because airframes contain most of the metals known to man, aircraft parts must be constantly protected against galvanic corrosion, the electro-chemical action of metals on one another. Finding finishes and plating methods to give aircraft parts this needed protection has been one of the major projects of the Manufacturing Research and Development group.

In a recent series of experiments, the group tested a large number of lacquers in order to find one which could withstand extremes of hot and cold temperature. The finishes were subjected to abrasives, heat, cold, and salt spray to determine the best protective coating for each different type of metal from the standpoint of durability, appearance, abrasion-resistance, and hardness.

The following test procedure, used to test the effects of aerodynamic heating on various experimental lacquers, is typical of the systematic methods used by Convair researchers to determine the best possible product for each application.

Finishes to be tested were applied over primer; then they were placed in a controlled atmosphere to cure for two weeks. After curing, the specimens were placed in an oven which had been modified to provide alternate 30-minute cycles of heating to 245°F, and cooling to approximately 98°F.

After heating, the specimens were tested for adhesion, gloss, and hardness. Adhesion tests consisted of scribing the lacquer into numerous small squares, then applying masking tape over the squares and removing it rapidly. Areas, where paint adhered to the tape, were measured and noted.

The specimens were then subjected to a controlled impact with a .5-inch diameter ball. The tension side of the indentations were taped; then the tape was abruptly removed to determine if there was any cracking or scaling of the paint film as a result of the impact.

When all tests were completed, the various lacquers were subjected to a visual test and compared to control specimens.

Other tests conducted by the research group on metal plates and finishes have resulted in improved protection against corrosion, better wearing surfaces, and improved formability during production operations.

Temperature indicating paints, which change color as different degrees of heat are applied, have also been tested and approved for Convair applications. They have saved the costly installation of thermal measurement equipment and provided multiple savings in airplane space and weight as well as in production time and cost.

summary

Not all of the experiments of Convair researchers are successful. In some cases, new equipment or a new process may prove to be uneconomical or less efficient than present methods. When this situation occurs, further research is abandoned.

In most cases, however, the efforts of the Manufacturing Research and Development group are successful. Numerous major and minor production problems have been solved by the group since its inception. Most of these problems have arisen during the production of military models, but the producibility barrier is not confined to military models and supersonic jets. Problems which are solved today have an effect also in lowering the cost and improving the quality of tomorrow's commercial airliner.

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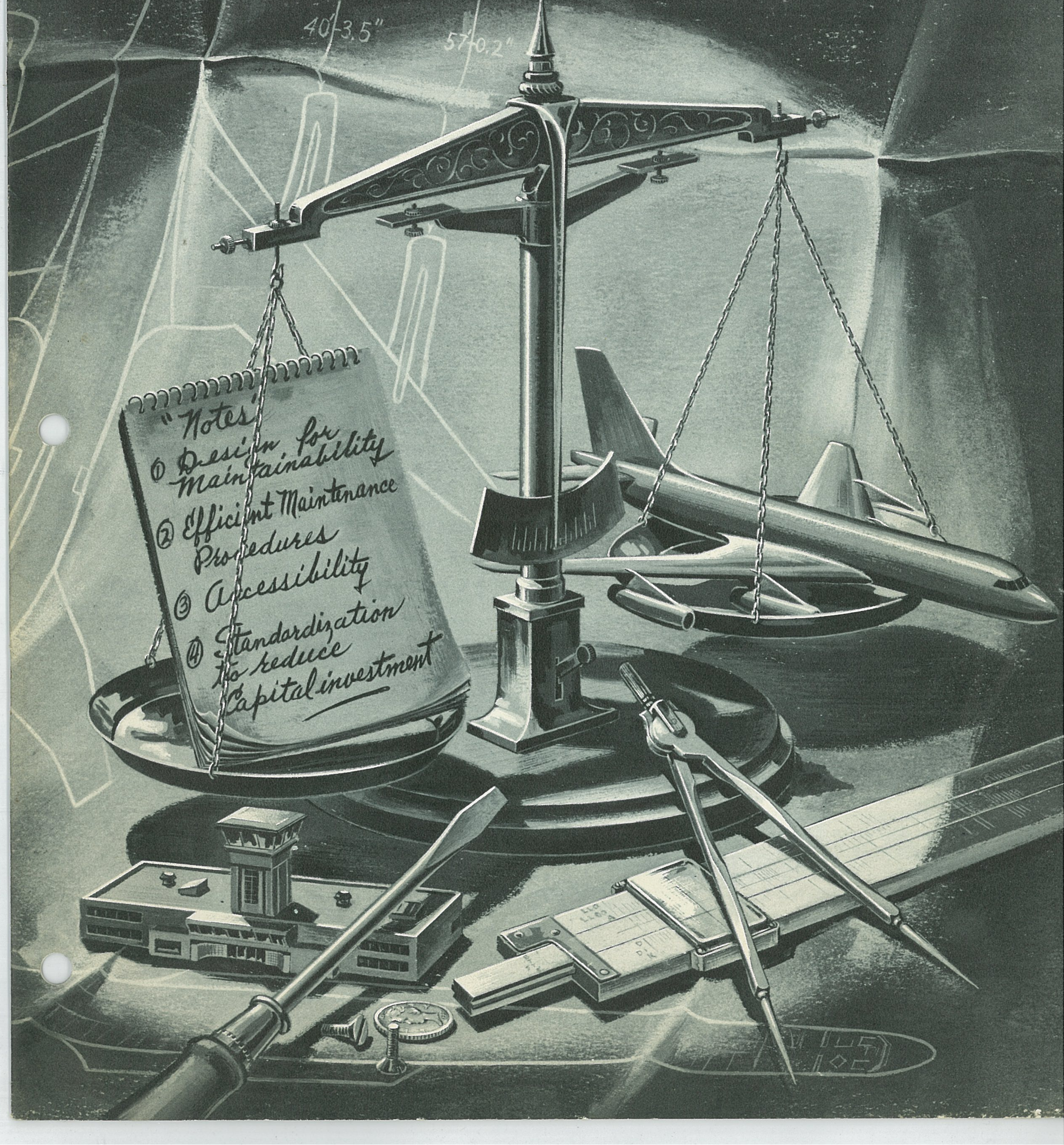
CONVAIR Traveler

VOLUME VIII NUMBER 12 APRIL 1957



CONVAIR Traveler

VOLUME VIII NUMBER 12 APRIL 1957

FOREWORD

As new aircraft are designed, the systems within them become more numerous and more complex. Putting more of everything into a limited space may affect the maintainability of the individual components; the maintenance engineer, therefore, comes into his own.

Due to the cooperative efforts of airline operators, and design and maintenance engineers, Convair's new jet-liner, the 880, will represent an important step forward in the field of maintainability. Service-tested features from previous models, and new features which were recommended by operators will be combined in the new jet-liner.

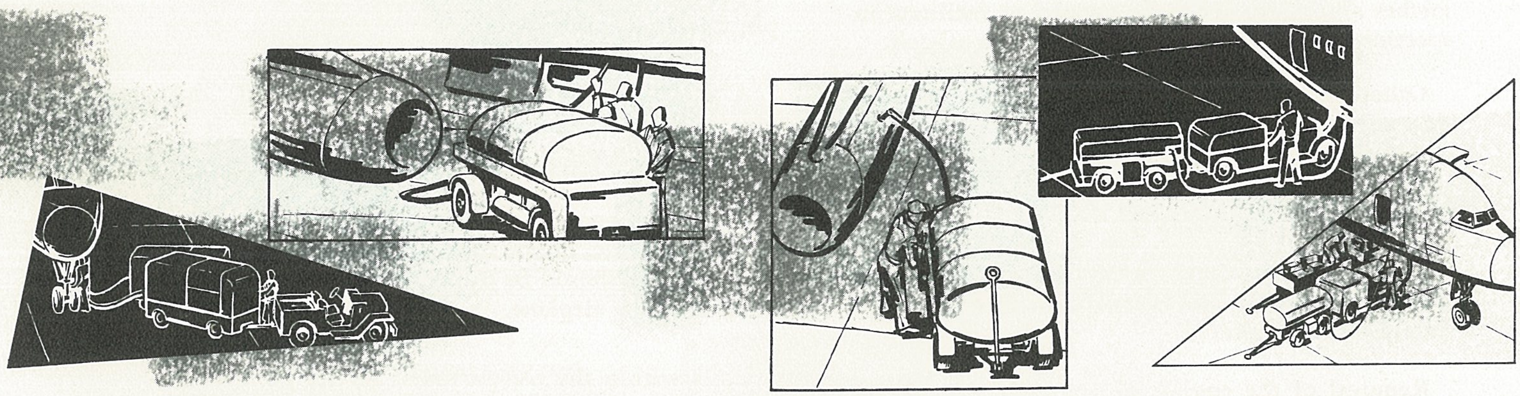
This issue of the Traveler is devoted to a description of the functions of the Maintenance Engineering and Operations Planning groups . . . two organizations which have been formed to expedite a new design-for-maintainability program.

ON THE COVER

A balance between performance and maintainability is reached in the Convair 880 through Convair's Maintenance Engineering group. Artist Jack Davis uses the maintenance engineer's notebook, the tools of the designer, and a jet-liner terminal building to symbolize this new concept in design . . . the design for maintainability.

A digest of Convair-Liner operation and service published monthly by the Service Publications Section of Convair in the interest of Convair-Liner operators. Communications should be addressed to Manager of Service, Convair, San Diego 12, Calif.

maintainability of the convair 880



Convair has long been cognizant of the necessity for efficient, rapid maintenance procedures in airline operation. Every possible improvement to facilitate access for inspection, lubrication, and replenishing was incorporated on the Convair-Liner 240 and, when the 340 and 440 designs were developed, customer suggestions regarding maintainability features were incorporated on these models.

Two groups of specialists at Convair are charged with the responsibility for maintaining this surveillance of operator's maintenance and servicing needs . . . one group, Maintenance Engineering, assists designers in the incorporation of maintenance features on new models, and a second group, Operational Planning, assists operators in the establishment of efficient ground support at minimum expense.

Maintenance engineers and operational planners are responsible for carrying out a far-reaching design-for-maintainability program which includes such activities as recommending servicing procedures to operators and fitting aircraft maintenance requirements to the customers' existing maintenance capabilities.

While the 880 was in the preliminary design stage, maintenance engineers made a thorough study of the aircraft. They analyzed each system and noted inspection and servicing requirements. Their observations, and suggestions received from operators, were then compiled in a report on maintenance design objectives.

Although the report contains specific recommendations which are referenced to the applicable design specification, it is intended to serve as a guide for designers, and not as a list of immutable requirements. The incorporation of recommended features in the airplane is dependent on such factors as structural integrity, weight and producibility. When these factors conflict with maintenance objectives, the conflicting elements are analyzed by maintenance and design engineers, and acceptable design requirements are established.

Many of the recommendations in the report of maintenance design objectives concern accessibility—one of the most important aspects of maintainability. Components requiring frequent service or inspection must be easily accessible and space must be provided to permit accomplishment of maintenance and minor repairs without disassembly or removal.

Ease of accessibility is of particular importance in the power plant area. For this reason, Convair-Liners are equipped with orange-peel cowling which provides maximum access and working space.

In order to provide equal accessibility to the 880's four General Electric CJ-805 power plants, hinged "clam-shell" cowl doors are used. Cowl latches are visible from the ground to facilitate inspection of locking mechanism prior to takeoff.

Other features listed among the maintenance design objectives are the following:

Pylons should be attached to the wing by means of easily accessible bolts and nuts.

Adequate access and inspection provisions for sound-suppressor and thrust-reversing devices should be incorporated.

Removal of the engine, or any engine accessory, should not disturb the basic rigging of power plant controls.

All engine accessories should be replaceable with the engine in place.

The 880 hydraulic system, like the power plant, will be designed to provide both maximum maintainability and maximum efficiency.

Following are some hydraulic system maintenance design objectives:

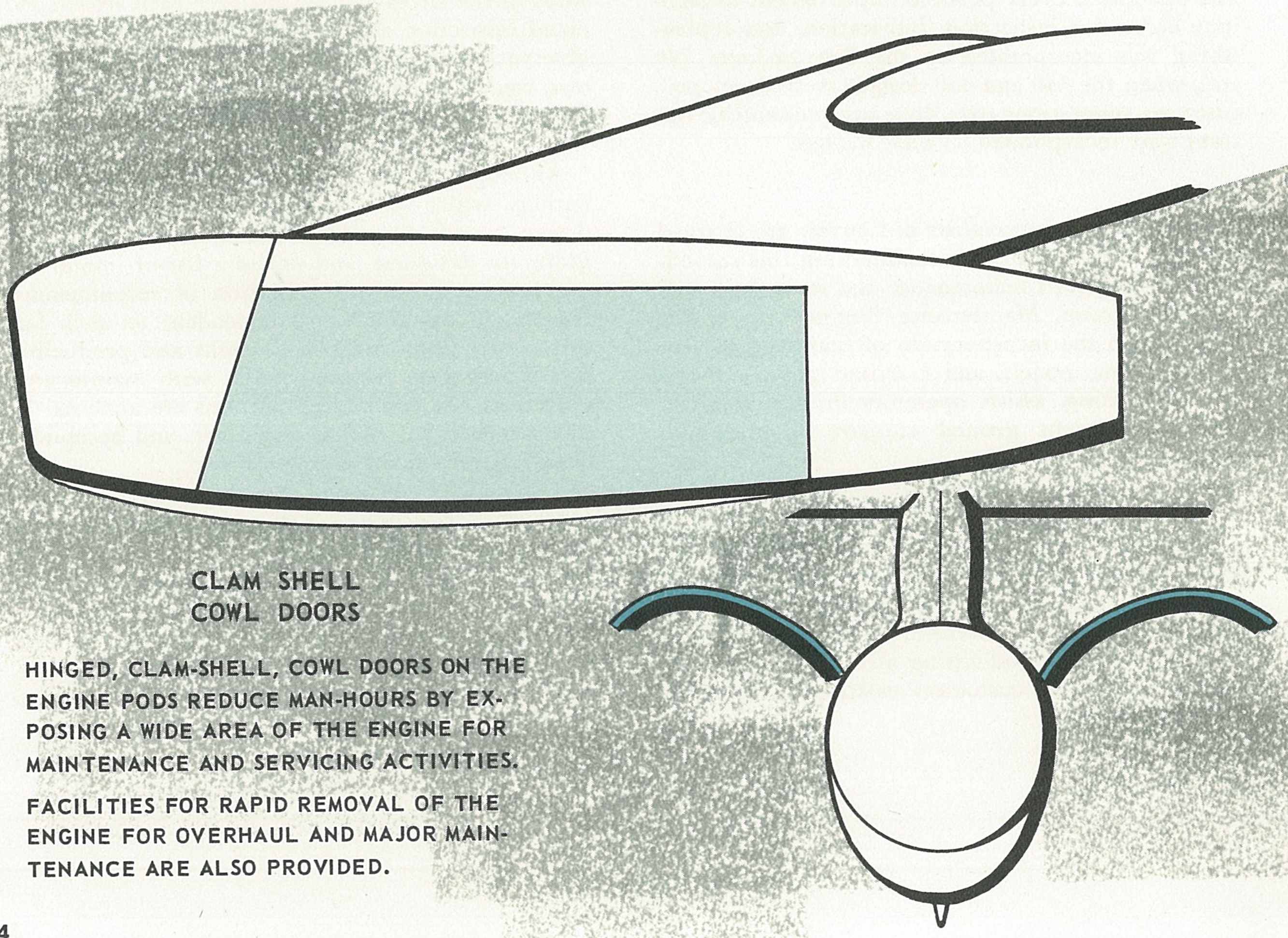
The system should be as compact and as uncomplicated as possible.

A minimum of units should be installed, and identical units should be designed whenever it is possible to do so.

Hydraulics components should be grouped, in so far as is possible, in one fuselage compartment. This compartment should be directly accessible from the exterior of the airplane.

Units within the compartment should be located to provide ready access for inspection or adjustment.

Another important maintenance activity, which must be considered in aircraft design, is structural inspection.



HINGED, CLAM-SHELL, COWL DOORS ON THE ENGINE PODS REDUCE MAN-HOURS BY EXPOSING A WIDE AREA OF THE ENGINE FOR MAINTENANCE AND SERVICING ACTIVITIES.

FACILITIES FOR RAPID REMOVAL OF THE ENGINE FOR OVERHAUL AND MAJOR MAINTENANCE ARE ALSO PROVIDED.

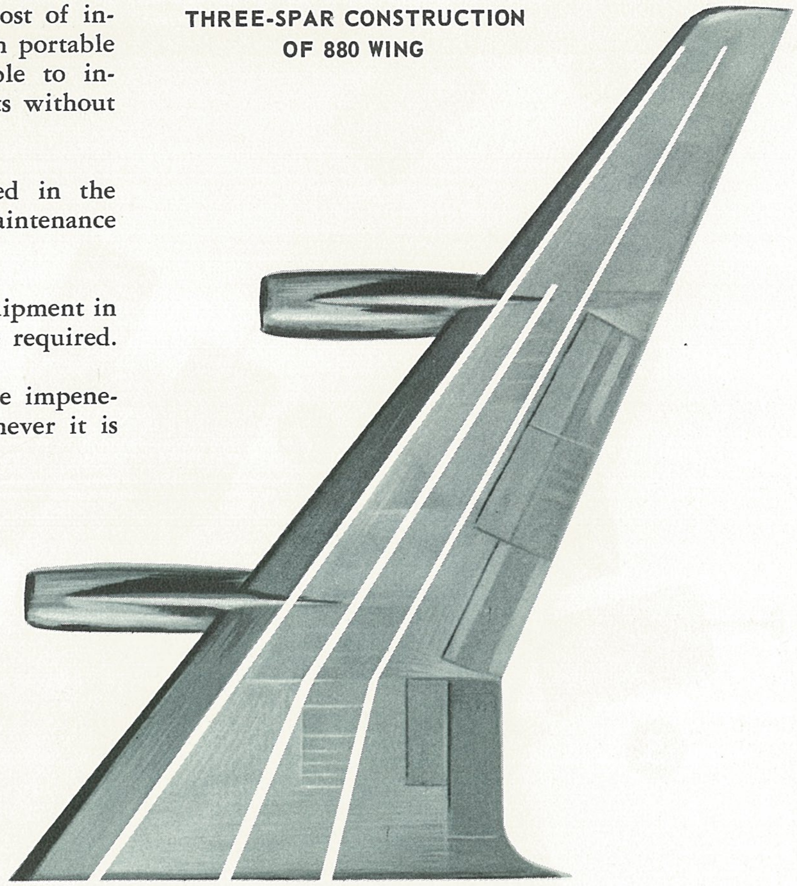
Many operators have found that the cost of inspection can be reduced considerably with portable x-ray equipment which makes it possible to inspect structure and structural components without removing the skin.

This development has been considered in the design of the 880, and two specific maintenance design recommendations are:

Access should be provided for x-ray equipment in structural areas where inspection may be required.

Materials, such as lead tape, which are impenetrable to x-rays, should be avoided whenever it is possible to do so.

THREE-SPAR CONSTRUCTION
OF 880 WING



When the 880 mockup is complete, maintenance engineering personnel will test all aspects of maintainability on the full-scale model. Each system will be checked for accessibility and ease of servicing. Necessary modifications will be accomplished at that time.

Ground servicing procedure development is a function of the Operations Planning group. While maintenance engineers are assisting designers by recommending maintenance features, they are also working with operations planning engineers in order to determine the most efficient servicing procedure for each customer.

Operations planners consider the ground support capabilities of each operator in relation to servicing features on the aircraft, and they can anticipate problems which may arise when a new model is placed in service. They conduct time studies on operations which are currently being performed on military and commercial aircraft, and they work closely with operators in order to reduce the amount of time required to complete each operation.

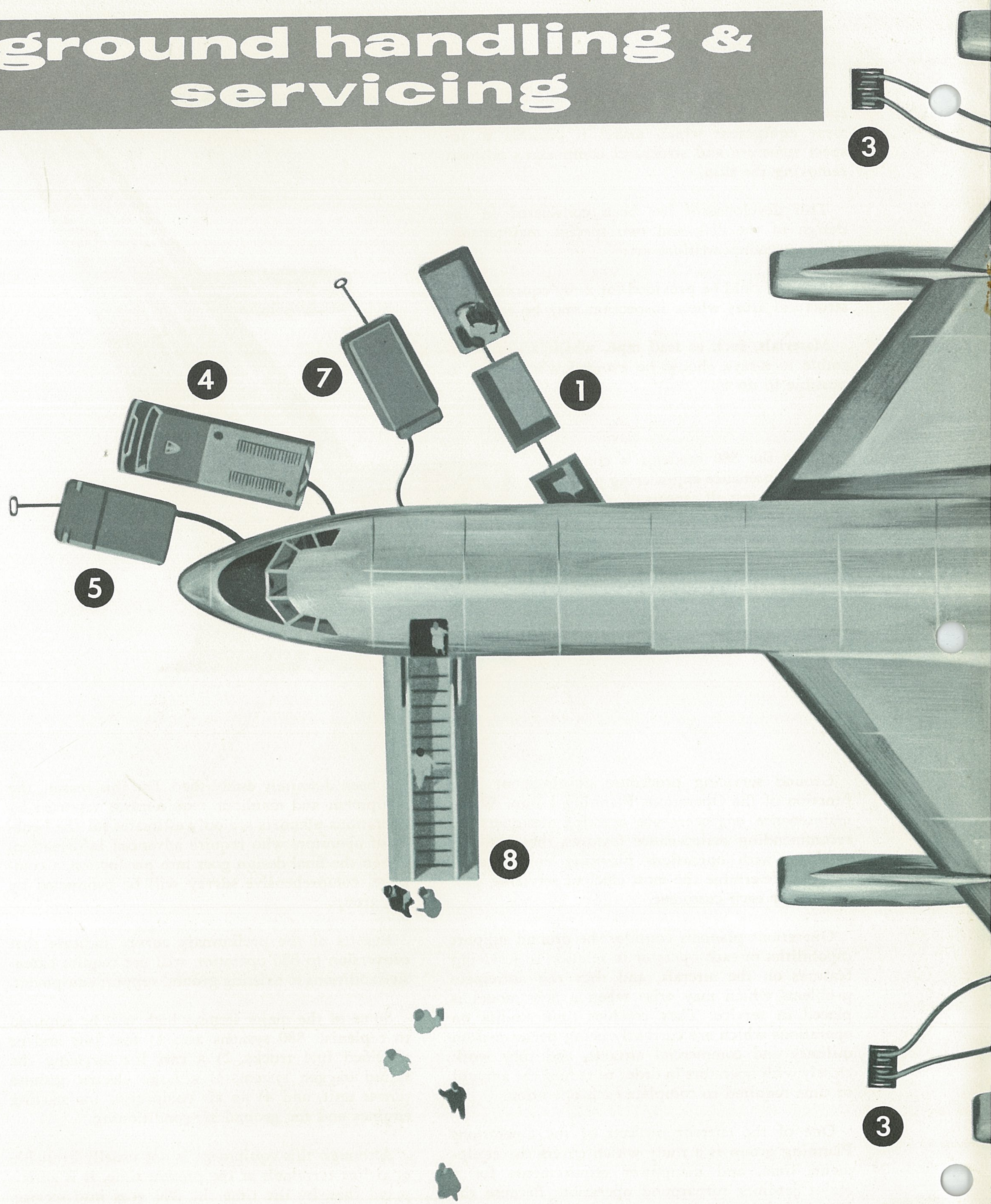
One of the current projects of the Operations Planning group is a study which covers the equipment, time, and manpower requirements for a major jet-liner turnaround operation. Because the 880 design is still being developed, however, the location of many components and access panels has not been definitely established. For this reason, the equipment and manhour requirements reported by operations planners are only estimates for the benefit of operators who require advanced information. When the final design goes into production, a complete, comprehensive survey will be conducted by the group.

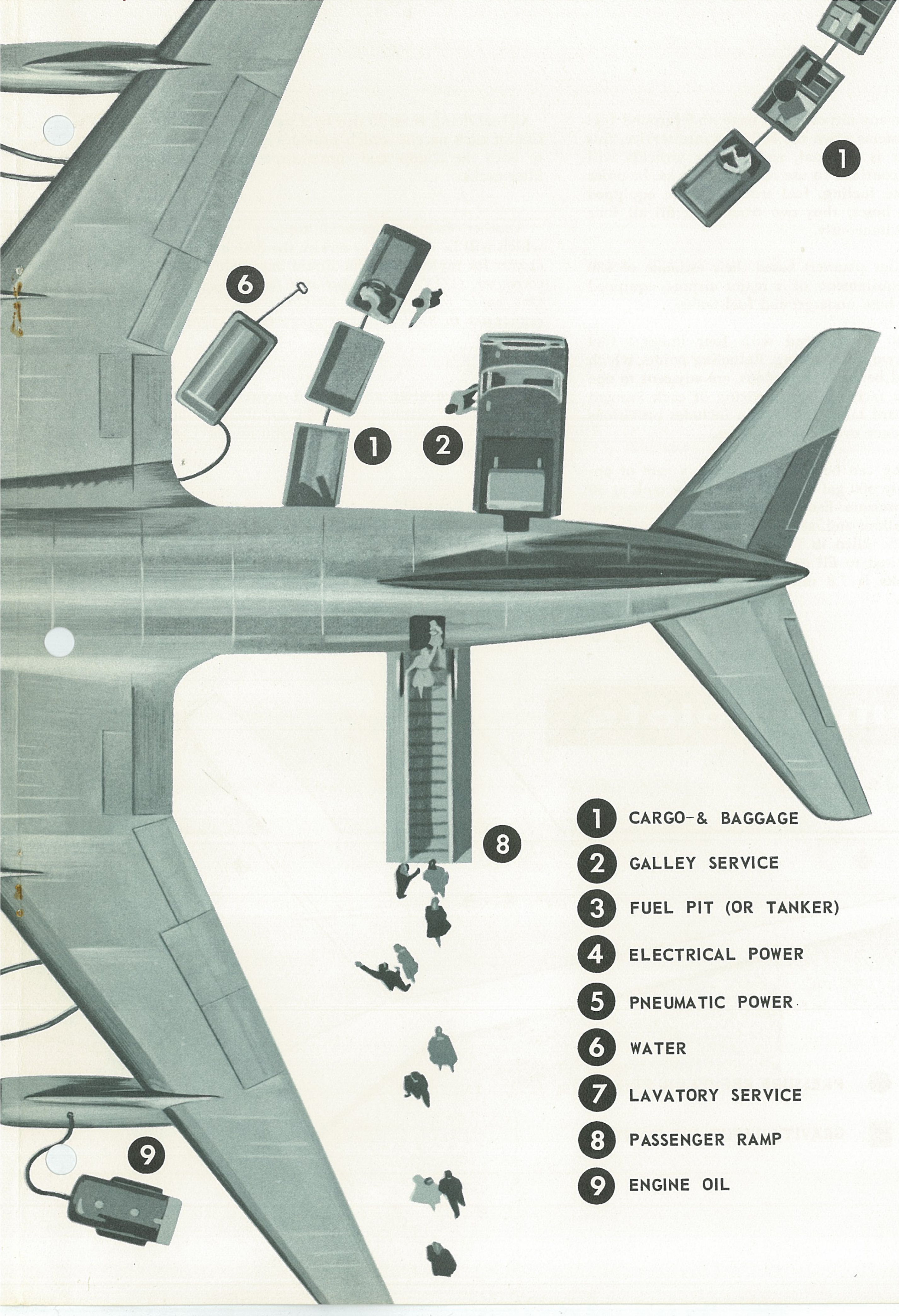
Results of the preliminary survey indicate that conversion to 880 operation will not require extensive additions to existing ground support equipment.

Some of the major items which will be required to replenish 880 systems are: 1) fuel pits and/or modified fuel trucks, 2) a cart for servicing the liquid oxygen system, 3) a large electric ground power unit, and 4) an air compressor for starting engines and for ground air-conditioning.

Although this equipment is not usually available at airline terminals at the present time, it is anticipated that, by the time the 880 goes into service, these items and other service equipment for jet aircraft will be in general use at most terminals.

ground handling & servicing

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6
1
2
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9
1 CARGO-& BAGGAGE
2 GALLEY SERVICE
3 FUEL PIT (OR TANKER)
4 ELECTRICAL POWER
5 PNEUMATIC POWER
6 WATER
7 LAVATORY SERVICE
8 PASSENGER RAMP
9 ENGINE OIL

While many airports will have underground fuel storage systems when the 880 goes into service, this equipment is optional, and smaller airfields will probably continue to use refueling trucks. In order to expedite fueling, fuel trucks will be equipped with two hoses; thus two trucks can fill all four tanks simultaneously.

Operations planners based their estimate of 880 fueling requirements on a major airport, equipped with four-hose underground fuel tanks.

The 880 is equipped with four integral fuel tanks . . . two in each wing. Refueling points, which are located between the pylons, are adjacent to one another to facilitate the servicing of each inboard and outboard tank. The system includes provisions for emergency overwing refueling.

Refueling can be accomplished at a rate of approximately 300 gallons per minute per tank at 50 psi gage pressure. Each inboard tank has a capacity of 3035 gallons and, according to current estimates, each can be filled in 10.2 minutes. The estimated time required to fill each of the 2350 gallon outboard tanks is 7.8 minutes. Refueling shutoff is automatic.

Oil servicing is facilitated by a panel on the right side of each nacelle which provides common access to both the engine and constant-speed drive unit filler necks.

Another item of ground support equipment which will be required to service the 880, is a truck or cart for replenishing the liquid oxygen, or LOX, converter. *(LOX is a concentrated form of oxygen. One cubic foot of LOX, weighing 71.2 pounds, evaporates to 850 cubic feet of gaseous oxygen at 14.7 psi.)*

The 880 converter stores liquid oxygen, converts it to gaseous oxygen, and then supplies gaseous oxygen to the regulator for distribution to crew and passengers.

The 880 has a 115/200 volt, three-phase, 400 cps, a-c power system. According to present estimates, a generator cart is required for ground power. The aircraft also has a 28-volt d-c system which is supplied by transformer rectifiers on the main aircraft bus.

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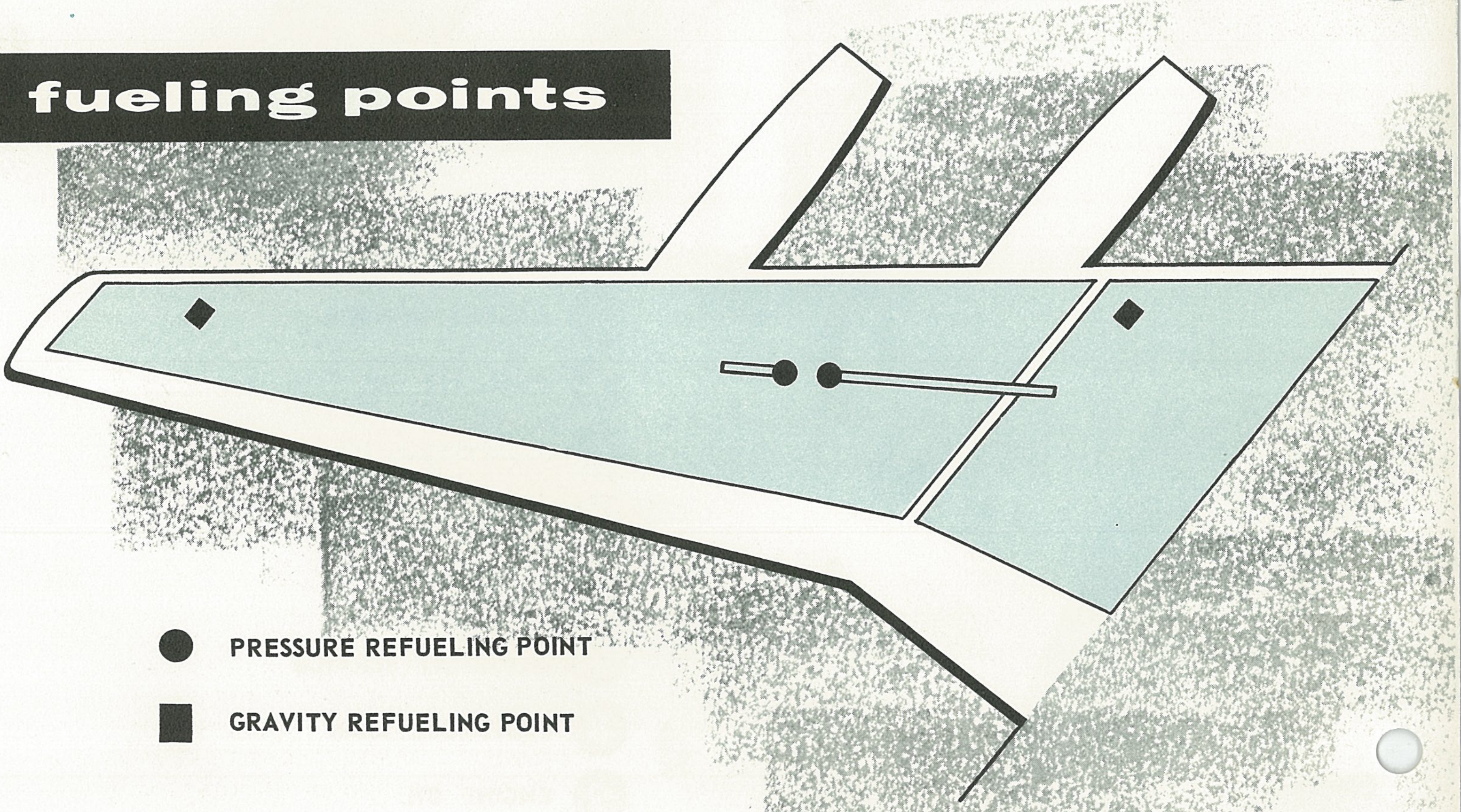
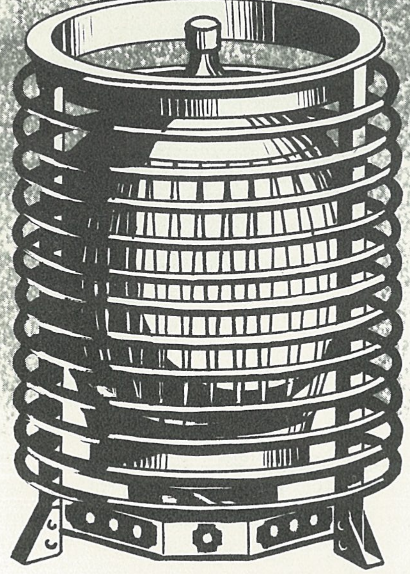
fueling points





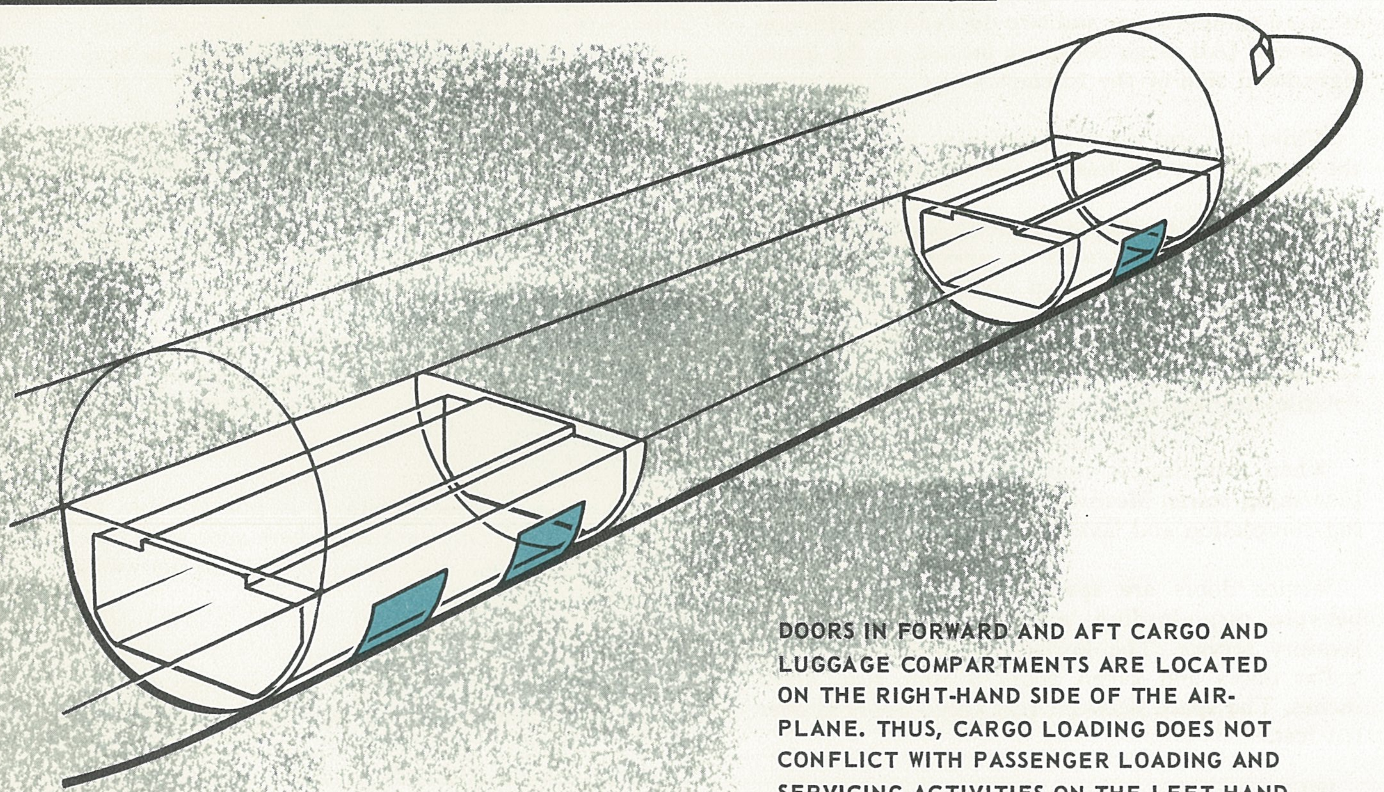
TYPICAL LOX
CONVERTER

An air compressor will be required for engine starting and, in some configurations, it may be used to accomplish ground air-conditioning, heating, and cooling. Some operators using electrically-driven freon compressors may use ground electrical power for ground air conditioning.

Water and lavatory servicing requirements on the 880 differ only slightly from those on Convair-Liners. Wherever possible, standard fittings are used on water and lavatory connections. Since the 50-gallon tank is charged with drinking water, it is not necessary to carry separate water containers aboard the airplane.

The 880 is designed to permit several loading operations to take place simultaneously without confusion. While galley servicing is accomplished through two service doors on the right side of the airplane, two cabin doors facilitate passenger enplaning and deplaning on the left side.

cargo compartments



DOORS IN FORWARD AND AFT CARGO AND LUGGAGE COMPARTMENTS ARE LOCATED ON THE RIGHT-HAND SIDE OF THE AIRPLANE. THUS, CARGO LOADING DOES NOT CONFLICT WITH PASSENGER LOADING AND SERVICING ACTIVITIES ON THE LEFT-HAND SIDE.

turnaround procedures

Concurrent with the survey of ground equipment requirements for the 880, operations planners conducted a study of turnaround servicing procedures.

Using model airplanes, trucks, and buildings, all of which were built to scale, the planners developed the following procedure for a typical ground check and replenishing operation.

When an 880 lands and taxies into position over the fuel hydrants, engines are shut down and ground equipment converges on the aircraft.

While passengers start to deplane, baggage carts are brought into position, refueling hoses are connected, and the water cart is positioned. Then air conditioning and ground power are supplied. As passengers leave the aircraft through the two main cabin doors, an oil check is performed, and refueling and baggage unloading continues.

When refueling nears completion, the center of activity shifts to the right side of the airplane where the galley service truck is in position. Cargo is loaded and unloaded through one cargo door in the forward compartment and two doors in the aft compartment. (All cargo doors are located on the lower right-hand side of the fuselage.)

While fuel and water replenishing is in progress, the clean-up crew is busy in the cabin.

The interior of the 880 is designed for convenience in cleaning as well as appearance. Fabrics which do not readily stain and which are easily cleaned with soap and water are used in cabin trim and upholstery wherever possible. This eliminates excessive rubbing or working with toxic and/or volatile cleaning solutions.

When refueling is complete, liquid oxygen replenishing starts. Meanwhile, galley service is nearing completion and lavatory service is started.

Service doors are spaced to eliminate conflict between cargo-loading, galley service, and water-lavatory service. The horizontal distance between buffet doors and cargo doors is four feet, eight inches. The space between rear cargo doors is over ten feet.

While servicing is being completed and baggage is being loaded, passengers board the aircraft.

After loading ramps have been removed, baggage compartments are secured and the area is cleared of all vehicles and personnel. Then, engines are started, and the 880 taxies to the runway . . . ready for takeoff.

As maintenance equipment and methods are modified to conform to the requirements of jet aircraft, airline terminals must also change. The exact configuration of future airline terminals is still a matter for conjecture; however, operations planners used their knowledge of jet-liner requirements to design the scale-model terminal which they used in their study of 880 procedures.

The scale model has a brick blockhouse at the end of a passenger walkway. The walkway is enclosed to provide protection from weather and from jet blasts.

An alternate method of passenger loading might be accomplished by using underground passageways from the terminal with an opening at the foot of the aircraft loading ramps. This would permit a greater number of aircraft to operate concurrently from the same terminal.

The areas around jet engine air intake ducts are dangerous during ground run-up, due to the suction of incoming air. The areas aft of the engine tail pipe are even more dangerous because of the high velocity and temperature of exhaust gases. These danger areas, which are common to all jet aircraft, are being considered in the design of new terminals. In most cases, aircraft will be positioned at least three hundred feet from the main terminal building.

At some terminals, where it is not possible to place jet aircraft in a position where spectators and ground crews are safe from jet blasts, movable fences may be required.

Preliminary studies indicate that six-foot panels, slanted back at a sixty-degree angle and weighted at the bottom, will effectively control jet blasts; however, further research is required to determine the exact design which will provide maximum safety at minimum cost.

SUMMARY

Each new increase in aircraft performance, speed, or load-carrying capacity is accompanied by a corresponding increase in system complexity. This situation is unavoidable to a certain extent; however, Convair engineers have proved in the past that complex systems need not necessarily require complicated maintenance procedures. In fact, simplified maintenance features have been incorporated in each new Convair design, despite increasing speed and performance requirements.

Concurrent with Convair's entry into the jet transport field, the function of lowering maintenance equipment and manhour requirements was assigned to the Maintenance Engineering and Operations Planning groups.

Prior to each design phase, maintenance engineers prepared a report on maintenance design objectives for the guidance of 880 designers, and operations planners assisted operators in the development of efficient maintenance and servicing procedures.

As a result of the efforts of the two groups, the 880 will not only be the fastest commercial jet transport in the world, it will also be one of the most economical.

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